ROADS AND STREETS

Design, Construction, Maintenance and Traffic Control

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***See the Road and Street Catalog & Data Book**

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ROADS AND STREETS

A Gillette Publication—Established 1906

Vol. LXXI *Chicago, July, 1931* *No. 7*

A $5,000,000 PROGRAM of Street Planning and Improvement

Completed Streets of the "Five Finger" Plan; Cahuenga Blvd. at Left

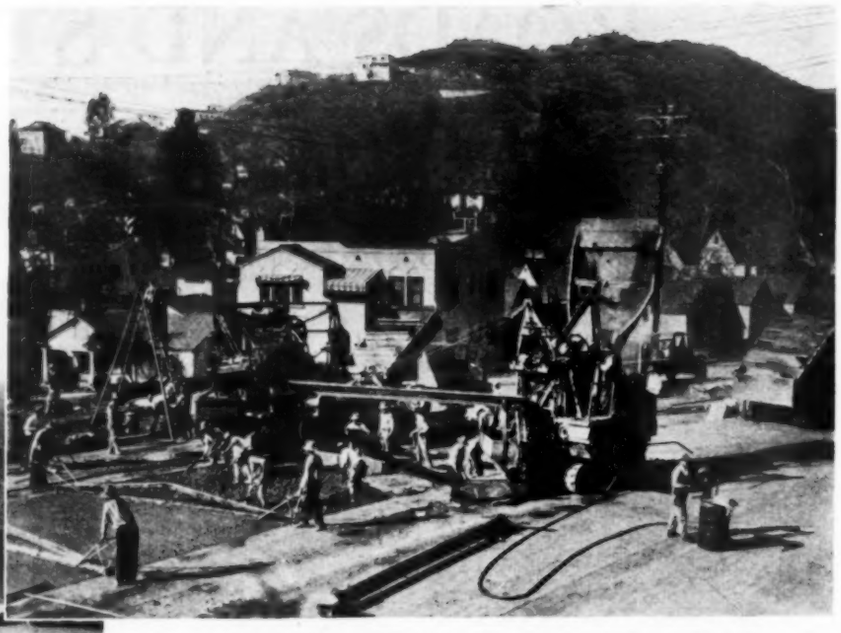
Extensive widening and paving program completed in Hollywood district of Los Angeles, Calif.—Special equipment for built-in traffic-lane markers—High-early-strength concrete used

THE "Five Finger" plan is the name given to the largest program of street widening and paving which was ever initiated for the Hollywood district of the city of Los Angeles, and which has recently been completed. The name suggests the arrangement of the streets in the plan, there being four fingers (north-and-south streets) and a thumb (an east-and-west street), all extending from the palm of an imaginary left hand which, figuratively, is Hollywood's business district. The work included widening these main traffic outlets and paving them throughout with cement concrete pavements having built-in traffic-lane markers.

Hollywood lies in a setting just below a main pass opening in the Santa Monica Mountains. A good portion of the traffic to points north of Los Angeles must of necessity travel through Cahuenga Pass, and must use the streets of Hollywood to reach the pass. It is because of this unusually heavy through traffic, in addition to the large volume of local traffic, that several wide streets running in the same direction and fairly close together are required. The Cahuenga Pass road which was built several years ago is concrete-paved to a width of 72 ft. and is so heavily traveled that a duplicate road is planned at the present time for the other wall of the pass. Main streets of the Five Finger plan are 56 and 74 ft. in width between curbs; secondary streets 46 ft.

The Five Finger plan improvement required the condemnation of private property for street widening purposes with awards to owners totaling approximately $4,000,000. Nearly another million dollars was required for the underground and surface improvements and street-lighting system. One set of proceedings was used to carry out the opening and widening of the streets and another, with a large spread in the assessment district, for the improvement work. The concrete type of pavement was selected by the property owners in the entire district by the use of a majority petition.

Construction. — The contract for the improvement work on the Five Finger Plan was awarded July 10, 1930, to the Will F. Peck Co. of Los Angeles. The amount of the contract was $813,613. The Los Angeles Department of Public Works stipulated that the streets be held open to traffic during the construction period. In order to hasten the work and interfere with traffic as little as possible, the paving plan involved the use of



Two Mixers Were Used to Speed Paving. Below — Calcium Chloride Was Pumped from Drums into the Water Stream of the Mixer

high-early-strength concrete (made with ordinary portland cement) in a portion of the job. Movements of the two mixers employed were so planned that the streets were always available for local traffic.

Grading consisted of removal of the old asphalt street surface, curbs, sidewalks and trees which fell within the new right-of-way. Cahuenga Blvd. was lowered in grade a maximum of 3 ft., with side cuts in former private property up to 15 ft. In all, there were 73,624 cu. yds. of cut and 7,444 cu. yds. of fill, the latter placed in shallow lifts and flooded. Coincident with the grading, a complete storm-drain system, sanitary sewers and water lines were placed.

Traffic Lanes.—Street widths for the Five Finger plan were made in accordance with the city engineering department's standard to provide for unit traffic lanes of 10-ft. width and marked parking zones. Secondary streets, 46 ft. wide between curbs, were placed in two 18-ft. strips along the curbs, and a 10-ft. strip in the center. Built-in traffic-lane markers or surface joints were placed 8 ft. from each curb. These, with construction joints between strips, have the effect of dividing the surface into three 10-ft. traffic lanes and two 8-ft. parking zones. The more important streets were designed for four and six traffic lanes with parking zones along the curbs, and built in a similar manner. The concrete pavement is principally of 8-in. thickness with edges thickened to 10-in. at all through joints.

Special equipment was designed on this work to facilitate the marking of the traffic lanes. On a 20-ft. strip (the maximum placed at one operation) the traffic-lane marker falls at the center. On a 17 or 18-ft. strip along the curb, the marker falls 7 or 8 ft. out from the curb. After the concrete had been deposited on the subgrade, it was screeded and tamped. The tamper was shod with a row of 3¼-in. strips of strap-iron to form a grid which would bring mortar to the surface. At the center of this tamper (for a 20-ft. strip) was attached a V-shaped, 4-in. angle iron, which would drive the coarse aggregate away from the line of the traffic marker. Subsequent floating did not bring coarse aggregate back into the depression and the slot was easily cut into the mortar which filled it.

To cut the slot, a guide and wheel were used. This wheel had a frame similar to that of a lawn mower with shoulders which rested on the guide and permitted the wheel to cut a uniform depth of 3½ in. For cuts on a radius, one guide which had flexible strips of 1x1½-in. wood in a rigid frame was set by measurements from three points at the edge of the pavement strip and held in place by thumb screws which tightened down on slotted strap-iron fasteners. This guide was also used for final edging.

Surfacing.—Careful attention was paid to the evenness of the riding surface and good results were secured with two longitudinal floats. Both of these floats were

Cutting Wheel Used for Transverse Weakened-Plane Joints as Well as for Traffic-Lane Joints

A Section of Completed Pavement

made of channel steel and were 18 ft. long. They were operated from bridges. The first longitudinal float, which served as a planer, had a face 7 in. wide while the second and final float had a face 4½ in. wide. While there is a tendency for steel-shod floats to leave a glossy surface, a light belting served to roughen the texture to provide a non-skid surface without disrupting the evenness.

High-Early-Strength Concrete. — For the sections placed with high-early-strength concrete, an admixture of 3 pints of calcium chloride per sack of cement was pumped in solution from drums into the water stream feeding the mixer from the measuring tank. Concrete was carefully designed with blended coarse aggregates and sand for a 1:2:3½ mix, and was placed at a slump of 1 to 1¼ in. This concrete was cured by sprinkling and opened in 72 hours. Cores drilled at 48 hours and tested at 72 hours averaged approximately 3,000 lb. per sq. in. One precaution was taken at joints to prevent the edges from chipping off under the first traffic by the simple expedient of a light earth cover over the joints. One third of the yardage, totaling 140,271 sq. yd., was of the high-early-strength type.

The entire work on the Five Finger plan was completed and the roadways were opened on March 16.

Final Edging and Trimming, Using Flexible Guide Devised for Joints on Radii

The Five Finger plan improvement was designed and built under the supervision of the Los Angeles city engineering department. John J. Jessup is city engineer; W. E. Brown, district engineer of Hollywood; C. J. Shultz, engineer of street design; H. P. Cortelyou, engineer of construction, and C. E. Trotter, resident engineer. Members of the contracting firm in charge of construction were E. H. Bashaw and C. P. Cook.

▼

Motor Bus Impacts on Highways Measured by Federal Engineers

When the wheel of a motor vehicle passes over an obstruction or a rough place in the surface of a highway, there are two impacts of the wheel upon the road —shock impact when the wheel comes in contact with the obstruction and drop impact when it hits the pavement following the bounce.

The trend today is toward higher vehicular speeds, particularly with the heavier wheel loads, such as in motor bus operation, and the Bureau of Public Roads, U. S. Department of Agriculture, has studied the impact forces produced by the rear wheel of a modern bus operating on a concrete pavement at various speeds up to 55 miles an hour and over two types of road obstructions. The studies have included various wheel loads, sizes of tires, inflation pressures, rim dimensions and rim widths. The Rubber Manufacturers Association and the Society of Automotive Engineers cooperated in the investigations.

The tests revealed that the impact varies in almost direct proportion with tire inflation pressure. The variation of impact with speed proved to be different for the two types of impacts, drop and shock. The drop impact reached a maximum value at comparatively low speeds and decreased at higher speeds. The shock impact varied almost directly with speed, but did not attain a value as great as the maximum drop impact until a very high speed had been reached. The relations of the various factors in detail are described in the April issue of *Public Roads*.

These bus impact tests are the latest of a series of impact investigations which the bureau has been making for ten years or more. The earlier studies dealt with the measurement of impacts caused by heavily loaded motor trucks, especially those with poor tire equipment.

The recent studies were conducted on a concrete road at Aberdeen (Maryland) Proving Ground, through the courtesy of the Ordnance Department. The vehicle used was a modern high-speed bus chassis with a special body. The floor of the body was divided into small compartments for retaining 100-lb. cast-iron weights used to vary the loads.

The tire equipment included both high-pressure pneumatic and balloon types, and the range in size was from 7-in. high-pressure to 12-in. balloon. Inflation varied from 53 to 107 lb. per square inch. Rims were of 20 and 24-in. diameter.

The tests involved two types of obstruction, each 1½ in. high; one an inclined plane 30 in. long, and the other a rectangular obstruction 12 in. wide.

The magnitude of impacts was measured by a multiple-element contact accelerometer, consisting of ten sensitive elements, which was designed and built by the bureau as a modification of a single element instrument used in earlier impact tests. The accelerometer was mounted on the rear axle of the bus, and was in a position to respond to any vertical accelerations imparted to the axle by the wheel.

Completed Hot-Mix Pavement

Asphaltic Surfacing of Gravel Roads

Methods and costs of constructing 6.1 miles of cold-mix type and 7.4 miles of hot-mix type on adjoining sections of a Wisconsin highway

By C. R. Stokes
Material Engineer, Wisconsin State Highway Commission

WISCONSIN has a rather large mileage of gravel and stone-surfaced highways. Many of these are in splendid condition and it is likely that a large portion of them would provide excellent bases for preservation. A few have already been selected for purposes of experimentation and various types of resurfacing have been tried. This paper can hardly cover the various types but will describe a section of highway built during the 1930 season, which presents some rather interesting features.

U. S. Highway 2 in Florence County in the extreme northeastern part of Wisconsin was selected for the work. This highway traverses the county for a distance of 14.05 miles and crosses the Michigan state line at either extreme of this distance. It carries an average of about 840 motor vehicles per day. The entire distance of 14.05 miles, with the exception of ½ mile previously paved in the village of Florence was included in the project.

The existing road was gravel-surfaced throughout and provided an excellent base for resurfacing. The soil adjacent to and under the road was in general a light sandy loam providing good drainage. There was one stretch of about 2,000 ft. where the road traversed fairly heavy clay soil and where at certain times of the year there was some frost-boil action. However, it was by no means an extremely serious condition.

Type of Surfacing Selected.—It was decided that the project should be split up into two sections and two types of bituminous surfacing, each having a full depth of 3 in. and an overall width of 20 ft. built. Each type was to have a thickened edge of approximately 5 in. extending in from the outer edge 1 ft. One section 6.15 miles in length was a 2-in. compacted retread base and a 1-in. top of cold pre-mixed bituminous material. The other section, 7.4 miles in length, was virtually a 1-in. asphaltic concrete top on a 2-in. asphaltic binder course. Bids were taken on the project with the exception of the work of blading and shaping the old gravel road and constructing the shoulders, this being done by county force account. Each section was let to two different contractors with separate outfits.

Inspection.—The project was ably supervised by a resident engineer of the highway department and a commercial testing laboratory. The state highway laboratory assisted in acceptance tests of materials. The commercial testing laboratory furnished experienced inspectors to supervise the actual work on both sections of the project as well as field chemists for the plant control. The author wishes to take this opportunity to commend the organization of the commercial laboratory for their fine work and cooperation.

Design of Types.—The actual design of mixtures, materials used, etc., were pretty well covered by the specifications, although some changes were necessary. The primer coat for the whole road was a light cut-back asphalt. Commercial crushed limestone and trap rock having a French co-efficient of approximately 10 was used in the retread base course and the bituminous applications were of heavy cut-back asphalt. The pre-mixed cold bituminous top consisted of 80 to 90 per cent of stone graded from ⅝ in. down, 5 to 7 per cent of bitumen and a small percentage of liquefier and filler. The mixtures for the asphaltic concrete section were designed to maximum stability, workability and compressibility. Each 1,000 lb. of binder contained 40 to 43 lb. of asphalt cement, 200 lb. of sand and approximately 760 lb. of stone. Each 1,250 lb. of asphaltic concrete top consisted of 68 to 70 lb. of asphaltic cement, 494 lb. of sand, 536 lb. of stone and 150 lb. of filler. The asphalt cement was a Mexican paving asphalt of 70 to 80 penetration. The stone and sand for these mixtures were furnished from the contractor's local screening and washing plant op-

erated locally near the project. They were produced from a gravel pit, where the general run of the material was of a hard, igneous type. Some fine sand was obtained from a bank near the asphalt plant set-up. The stone for the binder course was well graded up to 1½ in., and that for the top up to ⅝ in.

The mixtures for the hot-mix section seemed to bear out the advantage of carefully designing and controlling such mixtures. They were remarkably uniform from day to day and were very easily handled and compressed. Densities of mixtures were computed from laboratory samples and field samples of the rolled mix and showed an average of 2.40 for the top and 2.42 for the binder. The stability of the top mix ranged from 42.5 to 45.8 lb. per sq. in. in shear. The use of such a soft asphalt cement is somewhat out of the ordinary, but it is entirely in line with the best practice, which should contemplate using as soft an asphalt cement as is possible without sacrificing too much stability The mix is more durable when a softer asphalt is used and less apt to crack. At the same time the shear results secured for the mixtures on this project should be ample to insure stability. The actual bitumen content was determined from the voids in the aggregate, and it was kept just below the amount required to fill all voids completely.

Preparing the Subgrade.—The work of preparing the road for the two sections was practically the same throughout. The gravel-surfaced roadway was first bladed and then a small V-shaped trench cut along the outer edges to take care of the thickened-edge design previously mentioned. The subgrade thus established was then prime-coated with the light cut-back asphalt at the rate of ½ to ¾ gal. per sq. yd. The amount specified was ¾ gal., but that actually used was dependent on how much the gravel would take up. This varied with respect to the quantity of clay present in the gravel and also as to the amount of oil still remaining, as the road had had an application of light road oil the year previous. Small areas of loose gravel or sandy subgrade were removed and later filled with the base-course composition. A complete detour was established for the project, and traffic was allowed over the road three days to a week after prime coating.

Construction Details—Cold-Mix Type.—As soon as feasible after the prime coat had been applied both contractors started the work of constructing or placing the surfacing on their respective sections. As the methods of construction were essentially different they will be taken up separately.

The first operation on the retread section consisted of the hauling and spreading of the crushed stone. The stone was delivered in railroad cars at a siding about midway of the section and loaded into trucks directly through batcher bins. It was hauled to the roadway and spread upon the subgrade in sufficient quantity to produce a 2½-in. loose depth overall, allowing for the extra material required to fill the side trenches. The stone was graded from ¾ to 1½ in. in size, and the amount necessary for the 20-ft. width was about 1,000 cu. yd. to the mile. After the stone was spread and bladed, all stone in the side trenches was removed and thrown into the roadway proper before applying bitumen. The heavy cut-back asphalt was applied by a pressure distributor at about 175 deg. F. in two separate applications of about equal portions with a total amount of ¾ gal. per sq. yd. After the first application the blading was started at once and continued until all stone was partially coated and the mixture attained a uniform color. The blading was from side to side and usually about eight separate bladings were necessary. Two and sometimes three power blades were used in this work. On a few occasions the stone with its first application of bitumen, after mixing, was bladed into windrows and allowed to stand overnight, when it was again spread out by blades before applying the second increment. Such procedure, however, might be inadvisable under adverse weather conditions.

Immediately following the final blading after the first application of bitumen, the second was applied and the same process of blading was repeated. At this time the mixture was bladed into the side trenches. The last blading operation produced the final grade. During the blading operations it was sometimes necessary to resort to some handwork to keep the side trenches free of stone. After the last blading the base was rolled with two three-wheeled 10-ton rollers until unyielding. Any low places which were present after rolling were filled in with material and rolled.

After the base course had been thoroughly rolled the keystone was applied by means of a spreader box attached to the trucks. This stone was a gravel aggregate graded from ⅜ to ⅝ in. and was applied at the rate of about 15 lb. per sq. yd. It was distributed by brooming or float-dragging and was then thoroughly rolled into the base. The base course was opened to traffic as

Retread Base After First Application of Bitumen

Graders Making First Turnover of Retread Base Course After First Application of Bitumen

soon as possible after the final rolling. The traffic helped to compact the base. There were no break-ups at any point in the base.

After about ten days of traffic on the base the contractor started laying the pre-mixed cold bituminous top. This material was manufactured at a rather distant point in the state and shipped to a siding near the job in railroad cars. Cars were steamed with 80 to 90 lb. pressure, which resulted in heating the mixture to about 125 deg. F. This was done to facilitate unloading. The material was unloaded directly into trucks by means of a clamshell bucket. The mixture was shoveled and raked into place by hand and rolled with a three-wheeled 10-ton roller as soon as raked. Washed sand at the rate of about 6 lb. per sq. yd. was then cast upon the surface to prevent "picking up" under traffic. It was immediately opened to traffic and after one or two weeks a seal coat of heavy cut-back asphalt was applied at the rate of about 1-5 gal. per sq. yd. and sand again cast over the whole surface. This completed the work on this section and the surface was finished except for the final compression which occurs under traffic.

Construction Details—Hot-Mix Type.—The mixtures for the asphaltic concrete section were produced at a railroad car plant with a rated capacity of 2,000 sq. yd. of 2-in. surface per day. The plant was equipped with screens for three sizes of stone and one of sand, with storage bins according to screens. Each ingredient was accurately weighed into a batch box which discharged directly into the pugmill mixer. Aggregates were delivered to storage piles at the plant by truck and handled to the material elevators by crane. Asphalt was supplied in tank cars and pumped from them directly to the plant via a single storage tank. In the mixing operation aggregates were drawn into the mixer first and were given a dry mix of 30 seconds for top and 15 to 30 seconds for binder. Then the asphalt cement was added and the whole mixed for another 15 to 20 seconds. It is believed that this procedure insures against thin films of asphalt cement in contact with mineral at 450 to 600 deg. F. as is so often the case when the asphalt cement is drawn together with or immediately after the mineral and no dry mix is given to bring dust and sand-stone to a common temperature of about 400 deg. F.

The policy throughout this section was to lay binder in the afternoon and cover it with top the next morning. A small portion of the work was laid by the usual hand methods of shoveling the hot mixture into place and raking out to grade. The other portion was laid by means of a finishing machine designed to handle asphaltic mixtures. This machine rode on secured steel side forms, set to grade. The front screed member was adjusted vertically so that it dropped down inside the forms when binder was being laid and rode the forms when top was laid. By virtue of the riding on top of the forms, the entire weight of the front screed mechanism rested upon the freshly placed top mix and the result was that very little so-called "knockdown" remained for the rollers. In other words, the screed applied an initial compression of very considerable consequence.

The binder mixture was delivered by truck to the roadway, deposited on the subgrade and shoveled roughly into place. It was raked out by hand or struck-off by the finishing machine. It was then immediately rolled by means of a three-wheeled 10-ton roller and a 10-ton tandem roller. On a part of the job the side trenches were filled in advance of the regular binder course and tamped in place by hand. This proved to be the best procedure on the all-hand work, but in the case of the machine-finished work, the trenches were filled along with the spreading of the entire width. There were some loose sections of subgrade especially at each location of the truck turntable, and at these points the loose material was removed and filled with binder, rolled in place. In fact, all unevenness of subgrade was corrected with binder mixture.

On all the machine work, the forms were required to be in place until after the top was laid, being removed immediately following the final rolling. On all hand-work they were removed the following morning after binder was laid, and were not used for top. Instead, wooden strips of the proper thickness were spiked along the outer edge of the binder laid the previous day. The top was laid in the same manner as the binder. The top mixture was delivered to the work at a temperature of about 325 deg. F., while the binder approximated 275 deg. F.

Both binder and top as well as the retread section were carefully straightened and any unevenness of surface immediately corrected. Following the final rolling of the top, portland cement was swept into the surface and rolled.

Labor, Quantity of Materials Used, Etc.—Some facts

about both portions which are rather interesting are as follows:

Retread Section:

Prime-coat work required distributor and 3 men.
Spreading stone required 3 trucks, 1 crane and 3 to 5 men.
Applying bitumen and general work on retread base course required distributor, 3 trucks, 2 blades, 2 rollers and 9 men.
Pre-mixed top required trucks, rollers and crew of 16 men.
Stone spread at rate of about 260 cu. yd. per working day.
Average pre-mixed top laid per day, 1,975 sq. yd.
Total cut-back asphalt used for prime coating, 48,888 gal.
Total cut-back asphalt used for base course, 60,330 gal.
Total cut-back asphalt used for seal coat, 12,023 gal.
Total crushed stone used for base course, 6,100 cu. yd.
Total pre-mixed top mixture used, 7,434,000 lb.

Asphaltic Concrete Section:

Prime-coat work required distributor and 3 men.
Plant crew, 1 foreman, 2 engineers, 11 laborers, 5 trucks and drivers.
Roadway crew, 1 foreman and 9 laborers on forms and turntable; 1 foreman, 2 rollermen and 11 laborers on laying operation.
Average production per 10-hour day of completed 3-in. pavement, 1,600 sq. yd.
Total cut-back asphalt used for prime coating, 45,614 gal.
Total binder mixture, 12,750 tons.
Total top mixture, 4,973 tons.

Ideal weather conditions prevailed throughout the work. There was very little rain and the weather was hot, the temperature averaging about 78 deg. F.

Costs.—As far as the cost of this type of improvement is concerned, the figures available are based on the actual contract prices. The force-account agreement with the county for preparing the subgrade and reshouldering amounted to $1,100 per mile. The cold-mix section involved 72,830 sq. yd. and the total cost per sq. yd. was $0.96. The hot-mix section involved 87,417.7 sq. yd. and the total cost per sq. yd. was $0.93. The total engineering cost on the whole project plans, inspection, supervision, tests, etc., amounted to $8,720. The cost per mile of the whole project, including the county force account, but not the engineering costs, amounted to $12,250. If the engineering costs are included the cost per mile would be $12,891.

Finished Surface, Cold Pre-Mixed Type

Finishing Machine on Hot-Mix Type

Conclusion.—Experience in the construction of these two sections suggests a few improvements and details which might be advantageous in further work of this nature. First of all it is believed that there might be considerable advantage in prime-coating work of this type considerably in advance of the actual construction. This would give traffic an opportunity to stabilize the subgrade and thus develop any loose or weak spots, which could easily be corrected during the work. The presence of fresh prime-coat material is not particularly objectionable on cold-mix work, but it is on hot-mix unless it has completed its evaporation. At the start of the asphaltic concrete section, a few small spots of freshly applied prime coat bled through the binder and top, and these spots had to be cut out and replaced. Secondly, in binding the prime coat for immediate traffic, pea gravel or small stone chips should be used instead of throwing on sandy and dusty material from the shoulders. This latter material tends to seal into a mat and prevent evaporation, which is essential in the use of cut-back asphalt.

The use of the V-shaped trench to produce the thickened edge is objectionable from the standpoint of construction. On the retread section it was practically impossible to secure as smooth a surface in the outside foot or so as in the main portion of the pavement, due to uneven compression in the trenches. On the hot-mix type laid by machine the trench section was more easily handled. It is possible that a widened base might be more desirable as an edge protector.

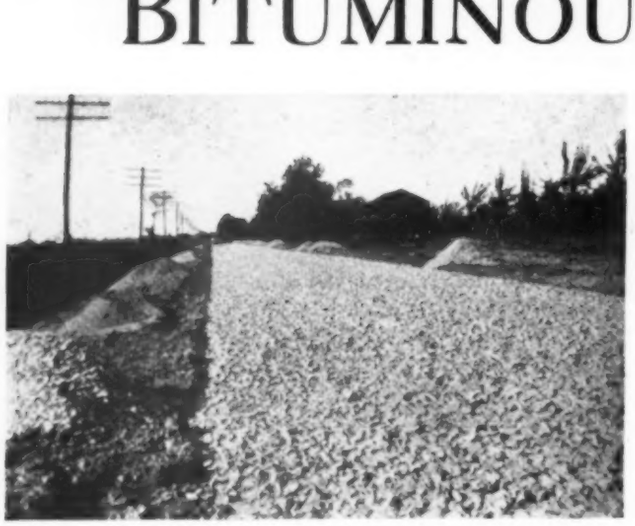
Undoubtedly one of the most interesting features of the work was the use of the finishing machine. A most excellent grade was left by the machine on both binder and top. Its use has been reflected in the riding quality on the section in which it was used, for there are less inequalities and unevenness in this portion than in the rest of the work.

An item of equipment which undoubtedly would have assisted very appreciably in the work, would have been the employment of spreader boxes on the trucks dumping hot-mix material. Two or three men could have been eliminated had the boxes been used. However, in general the two sections constructed in Florence County are satisfactory and, being two distinctly different types, it will be very interesting to observe their appearance after a few years of service.

Acknowledgment.—The foregoing is a paper presented at the 9th annual Asphalt Paving Conference.

BITUMINOUS MACADAM

Construction in Niagara County, New York



The 3-In. Penetration Course When First Spread

By RICHARD M. RUMSEY
County Superintendent of Highways, Niagara County, N. Y.

IN May, 1930, construction was begun on 3.5 miles of bituminous macadam (penetration method) in Niagara County and work was finished Nov. 1. Progress was made in a very workmanlike manner, starting, of course, with the excavation and construction of drainage structures. As this is a county of comparatively flat contours with average maximum grades of 1 per cent, the excavation ran about 3,000 yd. to the mile and was handled by a ¾-yd. Erie gas-air shovel. During the excavation period, shoulders and ditches were built and fine grading was done, care being taken that no large amount of dirt had to be moved on completion of the pavement. Shoulders and ditch lines were strung during the excavation and fine-grading period and so well was the work done that during the final trimming only reshaping of shoulders was necessary and not more than 100 yd. of dirt per mile had to be moved from its original position by teams, etc.

Constructing the Base Course.—As distances of 2,000 to 3,000 ft. of fine grade were completed, the bottom stone operation was started, all stone being local, crushed from the spoil bank of the New York state barge canal. No. 3 or 4 stone was used with enough No. 2 sprinkled in to insure the least amount of void space and the 10-in. base was laid in two layers of 5 in. compacted, the operation being the same for each layer. Stone dust was used for filler, about 175 lb. being used to the square yard for each layer with the compaction factor running around 25 per cent and all stone was laid down with stone spreaders, two being run side by side on the 16-ft. pavement. Experienced stone levelers filled depressions, etc., and when the stone had been properly placed a 10-ton tandem roller made one ironing pass. The filler was then spread and broomed-in, and rolling continued until the layer showed no weaving and would take no more filler, all excess filler being then broomed off. After the first ironing a three-wheel 10-ton roller worked in conjunction with the tandem. When the layer was thoroughly compacted, the second 5-in. layer of stone was applied in exactly the same way with one exception, that a little more care was taken in brooming-off the excess filler before the placing of the 3-in. penetration layer. During the construction of the 10-in. layer, weeps were placed in the shoulder to drain fully the bottom and were filled with base stone as the operation progressed. Great care was taken in laying the base to insure against unevenness, the opinion being that smooth-riding pavements are actually started at the subgrade as uneven bases cannot help but mean uneven pavements eventually.

Penetration Course After 1¾-Gal. Application. Surface Voids Have Been Filled with Large, Clean No. 1 Stone. Course Now Ready for ¾-Gal. Application

The 3-In. Penetration Course After First Dressing of Roller and Ready for 1¾-Gal. Penetration Application

The Penetration Course.—Only No. 3 stone was used

in the construction of the 3-in. penetration course, all effort being made to have a uniform size. When the stone was in place by means of mechanical stone spreaders, it was ironed out by the tandem roller, special care being taken to produce as level a surface obtainable in anticipation of the asphalt penetration. The Socony asphalt was placed with pressure distributors at the rate of 1¼ gal. per sq. yd., the asphalt being heated to 375 deg. F. and having a penetration of 100 to 110. This penetration produced more satisfactory results than asphalt with 90 to 100 penetration used the previous year as it was possible to roll out the slight variations to a greater extent. Immediately on completion of the penetration, about 40 lb. of large No. 1 stone was spread over the surface to fill the surface voids of the No. 3 stone and again the first rolling was done with the tandem roller, the purpose being to produce a

The 3-In. Course After ¾-Gal. Application. Remaining Voids Have Been Filled with No. 1 Stone. Course Now Ready for Seal Coat. The Roller Shown Proved Highly Satisfactory

smooth surface free from ruts, etc., before the three-wheel roller came in. From this point the two worked together, the three-wheeler being used for compaction primarily, and the tandem to iron out ridges left by the three-wheeler and also to produce compaction. This combination worked admirably throughout the job. The next step was the application of ¾ gal. per sq. yd. to seal the penetration and to tie the chinking stone in place, producing a rather close-textured and a well sealed surface. Approximately 40 lb. of No. 1 stone per square yard was sprinkled over the seal coat and then given another rolling. During these last operations, great care was devoted to obtaining a smooth surface. All the No. 1 stone was broomed around filling depressions and void spaces, none of the excess being broomed off, and when the ¾-gal. application was made, all loose stone was tied firmly in place. The road was now ready for the final seal and wearing coat.

The Finishing Process.—Heretofore, unless a pre-mixed top was used, we had always gone through the usual formality of applying a ¼-gal. application of asphalt with a thin layer of screenings thrown on and rolled in. This procedure had always given an unfinished appearance to an otherwise fine road and it was suggested that, in the absence of a pre-mixed top, the process be reversed. It had been tried in a few places outside the county with reported success, and on the strength of these reports, and our own previous experience, it was decided to experiment on a ½ mile. So gratifying were the results that the job was completed

First Step in Applying Seal Coat. A ¼-In. Layer of Clean No. 1 Stone Is Broomed to an Even Thickness

as started and the procedure and results are passed on to anyone who is interested in developing bituminous macadam pavements.

Immediately on completion of the seal coat a thin layer of No. 1 stone was spread and broomed about the surface, the brooming being done with a row of street brooms fastened to a car with no downward pressure applied. This layer was kept as thin as it could possibly be and still present the appearance of a carpet of No. 1 stone completely covering the texture of the No. 3, chinked with No. 1 of the penetration course. An application of ½-gal. per sq. yd. of carpeting asphalt was put down and allowed to lie for 24 hours, at which time it received one rolling with the three-wheel roller, and allowed to lie another 24 hours before opening to traffic. While the operation is a very simple one, it has helped a lot to increase the appearance of the road. It also has assured the holding of the carpet where it is needed most. After three months of traffic, the surface shows absolutely no signs of raveling.

Rolling the shoulders has been a very important detail of construction. As mentioned before, the dirt was placed in the shoulders previous to the placing of stone and was allowed to settle. After the road surface was completed, the shoulders were rolled 3 ft. from the edge with the 10-ton three-wheel roller to compaction, before any excess dirt was moved. It will readily be seen that the pavement edge was well supported against any transverse movement due to traffic.

Pavement Finished by ½-Gal. Application of Carpeting Asphalt. After 24 Hours the Road Receives Its Final Rolling and Is Immediately Opened to Traffic

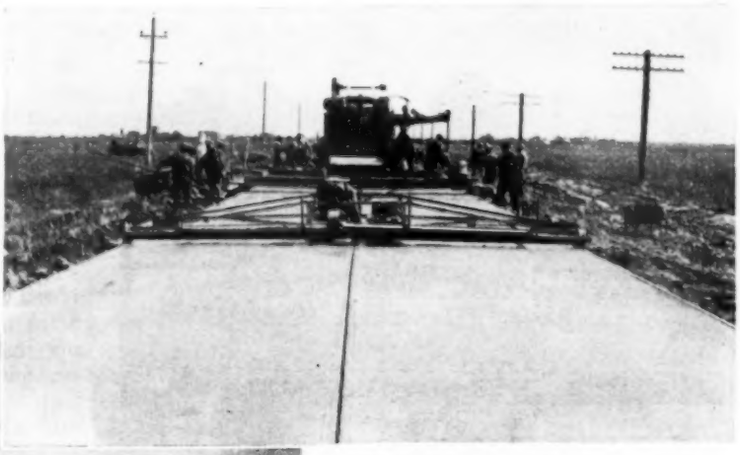
From the Sunny Kansas Plains

Construction Pictures from

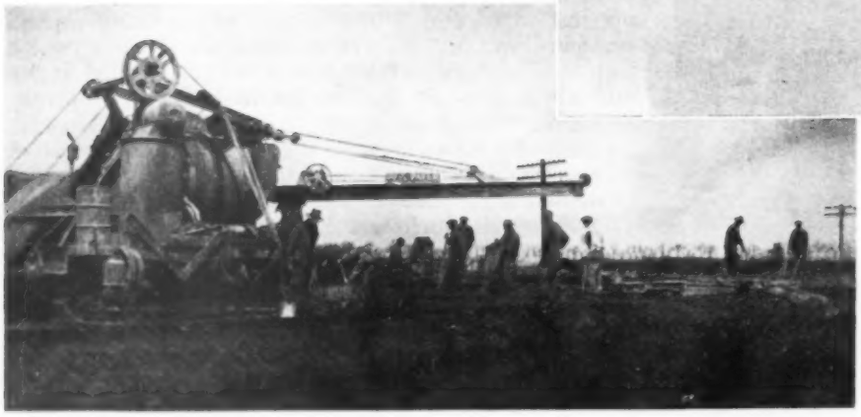
H. D. BARNES

Engineer of Construction, State Highway Commission of Kansas, Topeka, Kan.

Work in Progress on a 9-Mile Project of 20-Ft. Concrete Pavement on U. S. Route 40S Between Hays and Victoria. H. J. Taylor Construction Co., Salina, Kan., Contractor

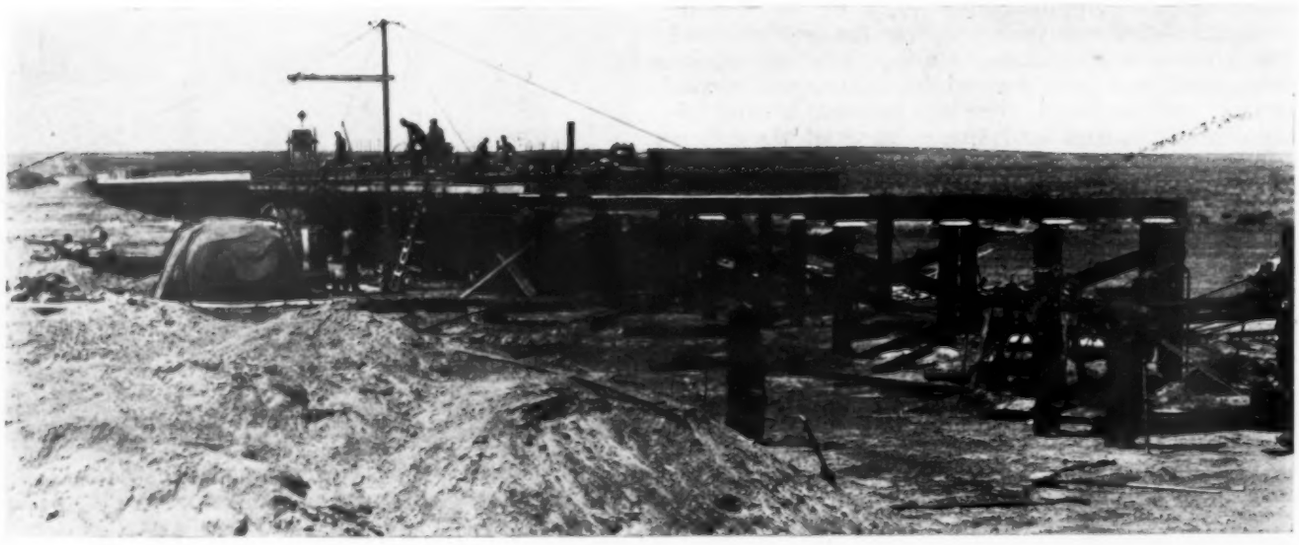


Below—Work on a 4-Mile Project of 20-Ft. Concrete Pavement on U. S. Route 81 from McPherson North. Roberts Construction Co., Lincoln, Neb., Contractor



Finishing 20-Ft. Pavement on U. S. Route 40S Between Hays and Victoria

This Crossing, Carrying Route K45 Across the Cimarron River Near Satanta, Will Consist of 54 22-Ft. I-Beam Spans Set on Creosoted Pile Bents. Thogmartin-Rein Construction Co., Fort Scott, Kan., Contractor



Tile Drains *Solve* Frost-Boil *Problem*

Michigan county places 33,000 lin. ft. of drains in 1930 at 42.5 ct. per lin. ft.—Method successful in preventing boils

By C. B. GOULD
Detroit, Mich.

AN interesting method for eliminating frost boils has been worked out by the county road commission of Washtenaw County, Mich.

Cause of Frost Boils.—During the past eight or ten years Washtenaw County and other counties in the United States north of the frost line have experienced trouble with frost boils in their gravel roads in the spring of the year. In the fall, the seasonal rains moisten the earth below the gravel road surface; then winter comes and the ground freezes and the water among the particles of earth changes to ice. This freezing action may occur a foot or more below the surface of the earth.

In recent years it has become the practice of the more important counties to clear their gravel roads of snow and in the case of such roads the frost line, of course, extends considerably deeper. In the spring, the temperature rises and the frost or ice begins to thaw out of the road surface. Naturally, the ice, immediately below the gravel, changes to water. The center of the road is protected by the gravel and the thawing action takes place there before it does in the earth shoulders of the road. For this reason the water from the ice cannot get from the center of the road out to the drain ditches and hence remains under the gravel and saturates the earth and gravel. With automobiles continually travelling over the surface, a pumping action takes place. Eventually, the saturated gravel and earth become soft and cars break through. The soupy material comes out upon the road surface and these things are called frost boils. They may be a few inches long or they may be several hundred feet long, or the entire road surface may break up for a distance of a quarter or a half-mile.

Prevention Method in Washtenaw County.—Washtenaw County experiences many such frost boils and the damage to the roads and the cost of maintenance were such as to cause the county to spend some thought on a solution for this difficulty. Their study finally led county officials to believe that if a trench were dug in the center of the road to a depth of approximately 4 ft., drain tile or corrugated pipe laid in the bottom of the trench, the trench backfilled with coarse material to within 6 in. of the surface and the balance of the trench backfilled with road gravel, frost boils where such drains were constructed would be eliminated. They reasoned that such a drain system would carry the water in the soil away, eliminating the formation of ice. When the thawing action took place in the spring, the water would drain into the trench and thus leave the surface of the road dry.

Ditcher at Work on Washtenaw County Roads

In the fall of 1929, they selected such portions of the road as had given the most trouble in previous years and put down approximately a mile of experimental drain ditch. In the spring of 1930, this road was watched very carefully and no trouble from frost boils appeared. As a result of the success of this experimental trench, Washtenaw County mapped out a definite drainage program for the summer of 1930 and placed approximately 33,000 ft. of drain in the troublesome sections of the gravel roads.

Construction of Center Drain.—A Barber-Greene ditcher was purchased to dig a ditch approximately 10 in. wide and 4 ft. deep. In the bottom of this trench, 4-in. vitrified drain pipes were placed and the trench was backfilled to within 6 in. of the surface with a stone up to a maximum size of 2½ in. The remainder of the trench—that is, the upper 6 in.—was filled with road gravel.

Under ordinary conditions this trench was located in the center of the highway. However, where conditions had been extremely bad, and it was decided that one trench would not take care of the drainage problem, two such drain ditches were placed each 5 ft. from the center-line of the road. When the line of tile has reached the end of the drain section, the trench is carried on an approximate angle of 45 deg. to the side of the road and the water emptied into a county drain or other suitable waterway. In the last 10 ft. of the trench,

TABLE I—COST OF CONSTRUCTING CENTER DRAINS

Name of Road	Total Amount Placed Lin. Ft.	Days Worked	Average Footage per Day	Average Cost Lin. Ft.
Saline	6,016	18	334	$0.40
Packard	1,147	3	382	0.36
Geddes—2	3,687	7	527	0.44
Geddes—1	8,876	16	555	0.48
Ridge	1,040	3	347	0.39
Superior	4,602	11	420	0.48
Portage Lake	6,588	15	439	0.42
Milan	1,240	3	413	0.44
Totals	33,196	76		
Average feet per day for season			437	
Average cost per lineal foot for season				$0.425

which is through the shoulder of the road, tiles are replaced with a 10-ft. length of 8-in. corrugated-iron pipe. The use of this pipe makes it impossible for the tile to become covered with earth or become broken due to spring frost action. At the right-of-way fence, opposite the beginning of the drain and the end of the drain, concrete marker posts with the word "Drain" painted on them are placed so that the men in charge of maintenance can watch for them through the year and see that they function properly.

Over 6 Miles of Drain Constructed.—The drains placed last summer were of varying lengths, some 200 or 300 ft. in length, and others a mile long. During the summer of 1930, the Barber-Greene ditcher dug a total of 33,096 ft. of drain ditch. The machine worked 76 days with an average of some 430 ft. per day for the entire season. Eight different roads were drained and Table I shows the number of feet on each road, the number of days and the average number of feet per day. The machine has dug as high as 800 ft. in 8 hours, but due to the varying conditions under which the machine worked, the average is considerably less. This ditching is extremely difficult because the drains are placed in or very near the center of the road and in gravel roads that have been in existence for years and have been packed almost as hard as macadam. A great many large stones requiring blasting were encountered and a large amount of corduroy at times delayed a daily footage. The county road commission plans to continue this work from year to year until the entire system of county roads has been properly drained in this manner.

A Center-Line Trench

A Truckload Ready to Move Away

Costs.—Table I shows the actual cost of placing such drains. It will be noted that the average cost per lineal foot amounted to 42½ ct. It must be borne in mind that this included the cost of excavating the ditch and disposing of the excavated material, cost of crushed stone, cost of road gravel, transportation of stone and road gravel, cost and transportation of drain tile, and labor.

The total operating cost of the machine for the season was $1,064, or 3.2 ct. per lin. ft. of trench dug. When the county placed the mile of experimental ditch in the fall of 1929, they had rented a ditcher for 10 ct. per lin. ft. and on this basis effected a saving of approximately $2,255 the first year of operation. For the purpose of estimating their appropriations, the county uses a figure of 5 ct. per ft. for the cost of trench excavating.

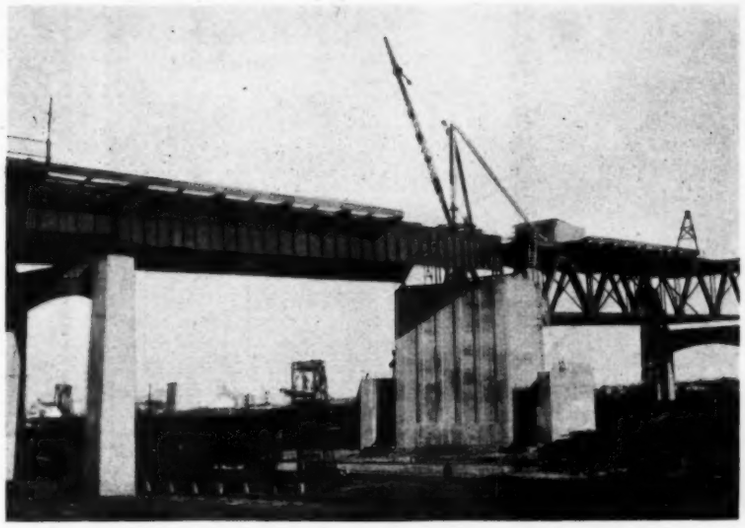
•

ROADS IN COUNTY DONEGAL.—With one exception, the county of Donegal has the largest mileage of roads in Ireland. In this county there are 3,700 miles of roads, of which 590 miles are classified as main roads.

A Record Plate-Girder Bridge Span

Transportation and rapid erection of two 84-ton highway plate girders 154 ft. long and 12 ft. deep

By FRANK W. SKINNER
Consulting Engineer, New York, N. Y.



Two 84-Ton, 154-Ft.-Span Plate Girders in Place in Approach to Maumee River Highway Bridge

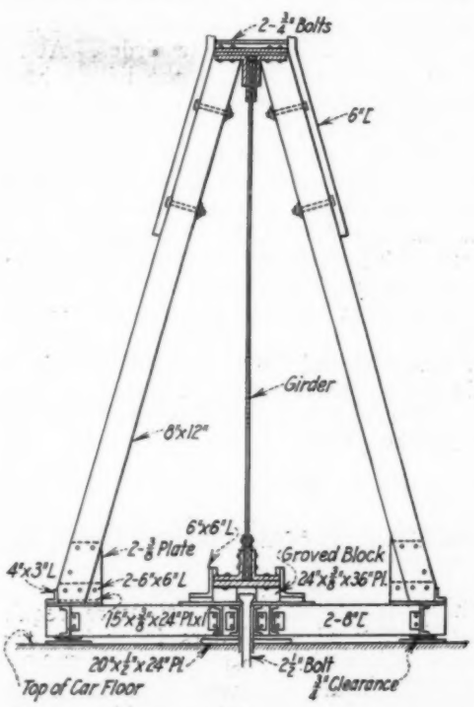
WITHIN about forty years, since the displacement of structural wrought iron by structural steel, members of plate-girder highway and railroad bridge spans have been built with constantly increasing dimensions; from spans of about 30 to 60 ft., they have advanced to common lengths of 60 to more than 100 ft. They are almost universally used for elevated railroad superstructures, and have to a large extent displaced truss spans of less than 100 ft. in bridges, bridge approaches and viaducts. Instead of being used chiefly for single-track railroads and light highway traffic, they are now used for much heavier locomotive loads on two, three or even four-track structures, and are built with heavy steel and concrete floors to carry congested highway traffic, including 25-ton trucks and steam rollers.

Their design and fabrication are simple standard operations, but owing to the extreme dimensions and weight of the longest spans, their transportation and erection often present special and sometimes difficult problems involving heavy steel equipment that has been greatly perfected within the last few years.

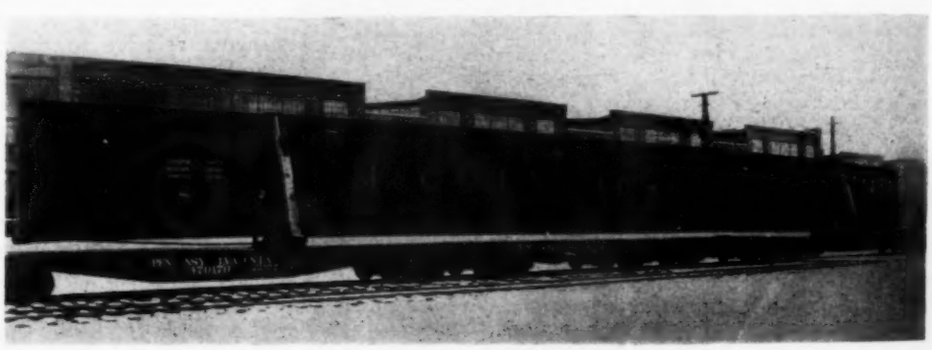
In the approach to the highway suspension span across the Maumee River in the city of Toledo, Ohio, there has recently been completed what is believed to be the longest plate-girder span yet built. It carries pedestrians and heavy city traffic on a reinforced concrete floor 66 ft. wide between handrails, and has a total dead weight of 2,028,000 lb., including the 580,000-lb. steel weight.

The two main girders, 153 ft. 10¼ in. long and 12 ft. 1 in. deep overall, have T-shaped plate-and-angle flanges and pin bearings on cast-steel rocker pedestals 152 ft. 6¾ in. apart on centers. The flanges, webs and end stiffeners are of silicon steel, and the remainder is of carbon steel.

The girders were each loaded at the fabricating shops near Pittsburgh on two 36-ft. flat cars with end car bolster bearings 117 ft. apart. These cars were sepa-

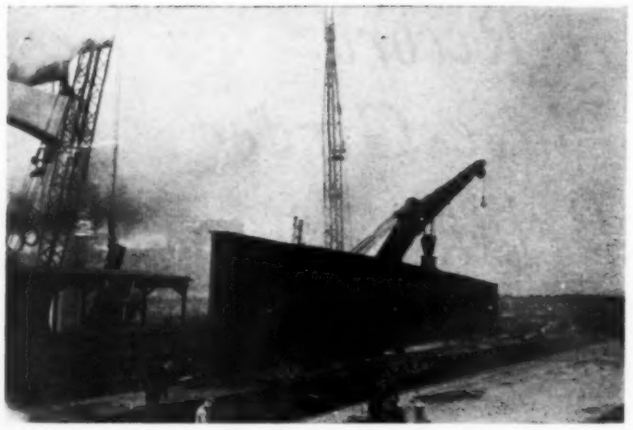


Above — Bolster and Braces Used in Transporting Girders

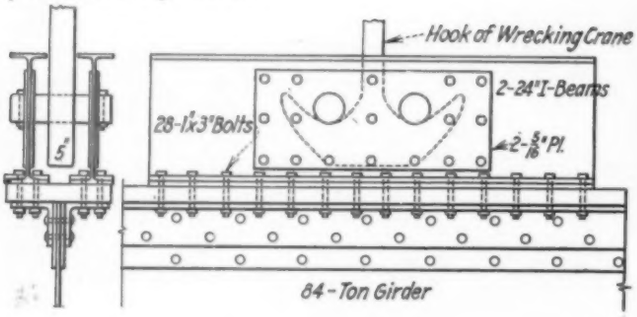


Right — Girder Mounted on Flat Cars

Right — Unloading with Railroad Wrecking Crane



Below — Connection for Unloading Girder



rated by two 50-ft. spacer cars. The structural steel bolsters were pivoted at the centers around 2½-in. vertical bolts through the car frame. They consisted of horizontal transverse sills 9 ft. long, with their extremities braced to the top flanges of the girders, and provided with bottom flange plates that just cleared the car floor, but took bearing on it if the girder web inclined from the vertical.

The girders were successively delivered at the bridge site on low-level tracks of the Wabash Ry. between the abutments. At the center of each girder there was connected to it a pair of 24-in. I-beams secured to the top flange with 28 1-in. bolts through open flange-rivet holes. Two horizontal pins through the webs of the I-beams engaged a double hook attached to hoisting tackle suspended from about the middle of the boom of a railroad wrecking crane that unloaded the girder, moved it a short distance to clear the track and placed it in position to be shifted a short distance by two 60-ton locomotive cranes at track level that set it in position for hoisting to place.

Lifting Beam, Locomotive Crane and Stiff-Leg Derrick at One End of Span

When erected, each end of the top flange was engaged by a pair of hooks attached to a lifting beam. The opposite ends of one of these beams were shackled to the hoisting tackles of two 60-ton locomotive cranes at track level, one on each side of the girder. At the other end of the girder one end of the lifting beam was shackled to the hoisting tackle of a 40-ton locomotive crane at track level, and the other end to the hoisting tackle of a stiff-leg derrick on top of the abutment, the lifting beams being positioned so that the 60-ton locomotive cranes each lifted 25 tons, the 40-ton crane lifted 15 tons and the derrick lifted 19 tons—all in proportions well within the stability of the long-radius booms. The unloading, shifting and erection of each girder were completed in less than one hour by ten men and a foreman.

This bridge was designed for the city of Toledo by Waddell & Hardesty, consulting engineers, New York, N. Y., and was fabricated and erected by the McClintic-Marshall Co., Pittsburgh, Pa.

▼

Prequalification Required for Oregon Bidders

On June 6th, the recent act of the legislature, requiring the prequalification of all bidders for public contracts in Oregon estimated to cost more than $10,000, became a law. The State Highway Commission will issue no proposal blanks to prospective bidders who have not in advance submitted certain prescribed statements relative to their financial condition, equipment and construction experience, and have been adjudged qualified to bid on, and to perform in a satisfactory manner, the work concerned.

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INTER-AMERICAN HIGHWAY SURVEY NEARS FINISH. —Five-sixths of the Inter-American Highway lying between the Texas-Mexican border and the Panama Canal have been covered by preliminary reconnaissance surveys, and approximately 2,300 miles of a total of 3,200 is possible for traffic during the dry season.

Jacking Conduit Saves Closing Main Thoroughfare

By HOLMAN I. PEARL
City Engineer, Crosby, Minn.

JACKING three lines of 36-in. corrugated-iron pipe conduits for as many sanitary sewer lines, through soil varying from sandy loam to both dry and saturated quicksand, under a main trunk highway within its city limits, was the means taken by Crosby, Minn., to assure the convenience of its citizens and of the users of the highway.

Crosby is a progressive city of 3,500 population situated in Crow Wing County, in the midst of the iron mining country of Minnesota. Passing through Crosby is State Trunk Highway 2, the main highway westward across the state from Duluth, Minn., to Fargo, N. D. During the summer of 1930, Crosby was engaged in making an extensive enlargement to its sanitary sewer system to provide sewerage facilities for outlying portions of the city.

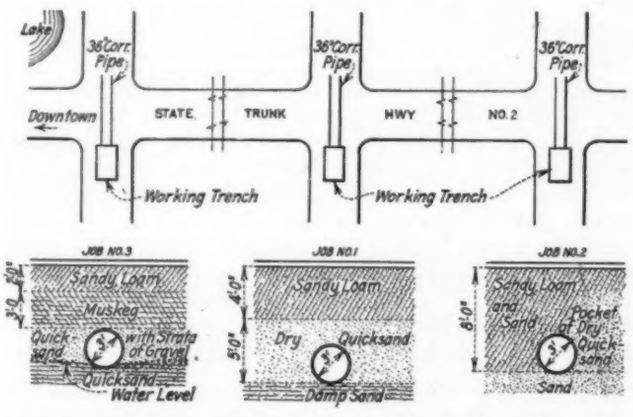


Fig. 1—Three Jacking Jobs in Crosby, Minn., Showing Soil Profiles

At three separate points, lines of the new sewer system were to pass under the concrete pavement of the state highway. Installation of these lines by the open-trench method was objectionable as it would necessitate blockading the street and detouring the heavy city and through traffic using the highway. Also, such construction would call for cutting through the concrete pavement. This could have been done, but it would have been followed by a period of maintenance for the settling fill and the replacement of portions of the pavement. Even the most careful reconstruction does not restore the pavement to its original condition, and a long period of maintenance is often required to keep the pavement in first-class condition. To eliminate these disadvantages, it was specified that those portions of the sewer under the highway should be installed by first jacking a 36-in. Armco corrugated-iron pipe under the pavement proper, and then laying cast-iron sewer lines within the opening thus created.

State Trunk Highway Under Which Three Lines of Corrugated-Iron Conduit Were Jacked

As shown in Fig. 1, the soil conditions varied for each particular job, and although the length of pipe required and the distance from the surface were approximately the same in each case, different practice had to be resorted to for each particular job. In each case, however, an approach trench was excavated in the intersecting street on the north side of the highway. The unstable soil conditions encountered made it necessary to sheet and brace the sides of the trenches very carefully. In spite of these precautions several caveins, common to mining operations in this section of the country, occurred and caused several hundred extra yards of excavation in the approach trenches. When the trenches had reached the required depth, mud sills and guide timbers set at the proper line and grade were placed in the bottom of the trench. Backstops, the construction of which varied according to the nature of the soil and the amount of pressure required, were constructed at the rear end of each trench.

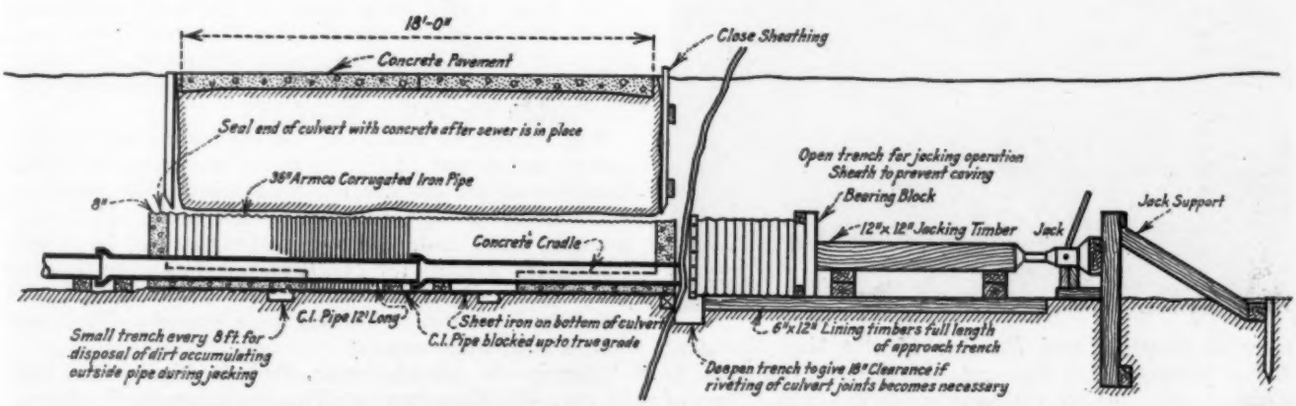

18'-0"
Close Sheathing
Concrete Pavement
Seal end of culvert with concrete after sewer is in place
36" Armco Corrugated Iron Pipe
8"
Concrete Cradle
Open trench for jacking operation
Sheath to prevent caving
Bearing Block
12" x 12" Jacking Timber
Jack
Jack Support
C.I. Pipe 12' Long
Sheet iron on bottom of culvert
C.I. Pipe blocked up to true grade
Small trench every 8 ft. for disposal of dirt accumulating outside pipe during jacking
6" x 12" Lining timbers full length of approach trench
Deepen trench to give 18" Clearance if riveting of culvert joints becomes necessary

Fig. 2—Section Through Installation, Showing Suggested Method for Jacking

The grades of the final sewer-pipe installations were to be as follows: at the first crossing, 4.45 per cent; at the second, 1.68 per cent, and at the third, 0.25 per cent. In order to allow some leeway for deviation in jacking the culvert, the guide timbers for the jacking process were set to bring the bottom of the culvert approximately 6 in. below the grade of the sewer invert. These timbers were carefully set to both line and grade. Despite the difficult quicksand conditions and other obstacles encountered in the jacking, none of the 36-in. culvert installations on completion at the far end of the pavement varied from true line or grade by more than 1½ in.

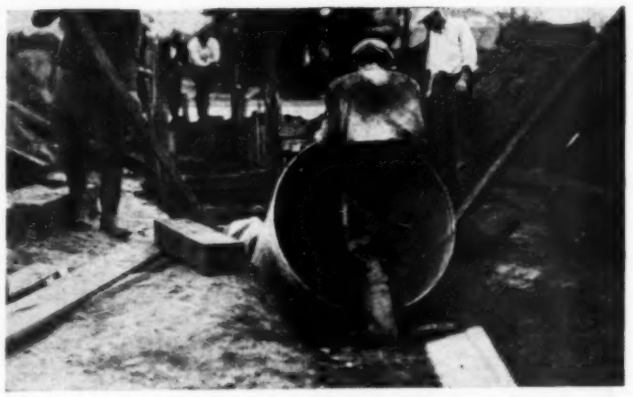
To reduce the friction of the surrounding soil, which would ordinarily settle into the corrugations and grip the pipe, a smooth iron sheet was fitted to the top of the pipe. Where there was an extreme lack of soil stability, a sheet was also fastened to the bottom of the pipe to give even greater freedom of movement.

The material encountered on the first crossing was uniformly dry quicksand. In spite of the precautions used to reduce the friction on the pipe, it "froze" when only 6 ft. of the total 20 ft. remained to be jacked. To overcome this difficulty, the necessary length of 30-in. pipe was jacked from within the 36-in. pipe already in place, to complete the distance required.

On the second crossing a pocket of dry quicksand above and to the right of the pipe was encountered. This made it impossible to excavate ahead of the pipe and made necessary precautions to keep large amounts of sand from running into the pipe and robbing the concrete pavement of its support. This was done by the use of a heavy plank shield, cut to fit the upper half of the pipe. In spite of this condition, the pipe was jacked to within 5 ft. of the required distance, where the forward progress was stopped by a broken jack. During the delay the pipe froze, and again a 30-in. pipe was jacked from within the larger pipe to complete the distance to the other side of the pavement.

From a casual examination, the third crossing promised to be the most difficult of the lot, because of the proximity of a large lake and the presence of water in the soil in large quantities. The only difficulty occasioned on this job, however, was the necessity for continuous pumping and the discomforts of working in from 10 to 12 in. of water at the freezing temperatures which prevailed before the job was completed. Also,

Careful Sheeting and Bracing of Working Trenches Were Necessary to Prevent Sand Runs Common to This Section of the Country. Note Unobstructed Pavement in Background



Lowering a Section of 36-In. Pipe Into Place on Guide Timbers

on this job a deadman and anchor-bolt were encountered, and these had to be cut and removed before the pipe could be advanced. This delayed the forward progress of the pipe only temporarily.

When the opening had been completed in the manner described above, cast-iron sewer pipe was laid within the conduit, 12-in. pipe at the third crossing and 8-in. at the other crossings. After this pipe was in place, the lower half of the conduit was filled with concrete and both ends were sealed with a concrete header. The cast-iron pipe was connected to the vitrified-tile lines that form the remainder of the sanitary sewer system.

Construction of the sanitary sewer extensions was carried out under the direction of the writer, who specified that the jacking method be used in installing the sewer under the highway. O'Neil and Preston, Inc., St. Paul, Minn., were the general contractors for the entire sewer system, while the jacking of the corrugated-iron conduit was sublet by them to the manufacturer of the pipe and completed under the supervision of H. S. Claybaugh. Reginald Nowell, mine inspector of Crow Wing County, assisted with valuable advice from his knowledge of local soil conditions.

▼

Engineering Societies Library Used by 40,000 Engineers

The main collection in the Engineering Societies Library comprised, on June 1, 141,546 books and pamphlets, according to a report by Harrison W. Craver, the director. During the first five months of 1931, 4,880 books and pamphlets were either purchased or received as gifts.

Of these, 3,030 were added to the main collection, which now represent 66,527 titles, indexed in the catalog under 37,100 subjects for ease in finding. The catalog contains 434,326 cards under 135,574 classifications. The budget for 1931 is $56,653.55.

The number of visitors to the library during the five-month period was 12,255. Service was given to 18,726 members of the engineering profession. The wants of 2,553 members were supplied by telephone. Forty-two searches were made and 89 technical articles have been translated. Orders for 21,691 photoprints were received from 2,136 persons. Information was sent to 1,561 members by letter, and books were loaned to 90 distant members at their request.

During the calendar year 1930 the library was used by over 40,000 engineers. This year, despite the depression, an even larger number will be served.

Is Vehicle Taxation Equitable?

An interesting communication appeared on page 723 of the April 11, 1931, issue of *Railway Age* which should be read by all highway engineers. Substantially, it is an argument presented with the two-fold purpose in view of offering a tentative basis for determining alleged fair and adequate tax rates and of stimulating further consideration of the subject of motor vehicle taxation. The communicants' method is founded upon a study of 1924 construction and maintenance costs of Illinois concrete highways, and motor vehicle tax payments. It is based upon the assumptions that motor-vehicle taxes should (1) fully pay the annual cost (interest on investment depreciation and maintenance) of the highway system, and should (2) be graduated according to the determining factor in highway costs, which, it is stated, is the gross weight imposed.

Following are some of the figures:

	Miles
Concrete and other hard-surfaced roads	8,447
Gravel and macadam-surfaced roads	12,928
All other surfaced roads	75,912
Total	97,287

Estimated construction cost of this system was given by Clifford Older, then state highway engineer, in testimony in I. C. C. Docket 23,400:

8,447 miles hard-surfaced road at $31,200 per mile	$263,546,400
12,928 miles gravel and macadam-surfaced road at $15,800 per mile	204,262,400
75,912 miles other surfaced road at $6,600 per mile	501,019,200
Total	$968,828,000

Mr. Older gave the annual cost of the highway system as follows:

Interest at 4 per cent on $968,828,000	$38,753,120
Amortization—concrete and other hard surface, based on 25-year life	3,716,680
Maintenance	21,796,092
Total annual cost	$64,265,892

The communicant, a special engineer for the Illinois Central System, states that a substantial part of the construction and other costs of the Illinois highway system is chargeable to use by heavy vehicles. Then he goes on to show how much the system should have cost had it been designed for a maximum load of 6,000 lb., i. e., had there been no trucks at all on the roads. After subtracting the estimated cost of 6,000 lb. loading (automobile) from Mr. Older's total annual cost he states the remainder, or $9,913,625 is charged to and should be borne by the heavier vehicles.

In continuing his communication he arrives as the following tax rates applicable to trucks only:

Tons Capacity	Weight With Load	Annual Tax at 3½ Cents per Lb.
2	11,000	$385
2½	12,500	438
3	14,050	492
3½	17,100	599
4	18,850	660
5	23,450	821
7½	30,000	1,050
10	40,000	1,400

These rates it is further argued represent total annual tax payments, including gasoline taxes and license fees, and should be assessed only in case of vehicles actually using the highways outside of cities. He suggests a similar method of calculation to establish taxes for vehicles operated entirely within cities.

F. A. Reimer Dies

Frederic A. Reimer, consulting engineer and past president of the American Road Builders' Association, died suddenly of heart disease on May 18 at East Orange, N. J.

Mr. Reimer was born in East Orange on Feb. 1, 1874. From 1895 to 1908 he was assistant city engineer of East Orange. In 1909 he succeeded his father as city engineer, and in 1911 went into private practice as a consulting engineer. He became assistant county engineer in 1912, and from 1913 to 1922 was county engineer. In 1922 he was field engineer for the Asphalt Association of New York and in 1923 he was representative of the Asphalt Association of New Jersey.

For fifteen years Mr. Reimer was a member of Battery A of East Orange, receiving his commission as lieutenant in 1904. In 1915, at the request of Governor Edge, he organized a battalion of engineers for the New Jersey National Guard which, in 1917, was nationalized as part of the 104th Engineers. Mr. Reimer took the battalion to Camp McClellan, Ala., in August, 1917, with the rank of major.

He was elected president of the American Road Builders' Association in 1929 and in that year represented the United States at the Pan-American Congress in Rio de Janeiro.

Mr. Reimer was a former president of the New York Society of Professional Engineers. He was a member of the American Society Civil Engineers of America and the Society for Municipal Improvements. He was a member of the Military Order of the World War, the Military Order of Foreign Wars, the American Legion, the Masonic order, the Kiwanis Club of East Orange, the Newark Athletic Club and the Chamber of Commerce and Civics of the Oranges and Maplewood.

Mr. Reimer married Jeanie Francis Peloubet on March 17, 1898. She survives, with two sons, William P. and Frederic P. Reimer; two daughters, Mrs. Harold Whitney and Jeanie P. Reimer; a brother, Arthur A. Reimer, who formerly was Water Engineer of East Orange, and a sister, Isabel Reimer.

New Upper Deck for Manhattan Bridge

The Addition of an Upper Deck to Manhattan Bridge, Connecting New York and Brooklyn, Has Increased the Motor-Vehicle Traffic Capacity of the Bridge from 65,000 to 95,000 Cars Daily

Markers Promote Traffic Safety

Central Parkway at Main Street. In Addition to Dividing Traffic Into Three Lanes, the Markers Are Used to Spell Out Turning Directions

Motor and Street-Car Traffic Halted at Fourth St. and Walnut St., while Foot Traffic Crosses in Perfect Security. Traffic Files Will Move Forward in Order when the Green Light Shows

METAL traffic markers have proved important adjuncts to traffic lights and police direction in moving the motor traffic of Cincinnati, Ohio, safely and expeditiously, according to Edgar Dow Gilman, director of public utilities. The permanent markers, typical installations of which are shown in the accompanying illustrations, have aided in inculcating better driving habits in Cincinnati motorists and have been responsible for increased street capacities, a decrease in the amount of police regulation required and a reduction in the number of traffic accidents.

Two Pictures Taken on Central Parkway, Showing Marker Installations. Traffic Is Disciplined to Move in Parallel Lanes, Utilizing the Maximum Traffic Capacity of the Boulevard

Street Cleaning at Toronto

Departmental organization—Yards and Plant—Patrolling—Street flushing—Road oiling—Snow removal

STREET-CLEANING organization and methods in the city of Toronto, Ont., are outlined in the annual report of George W. Dies, street commissioner, from which the material appearing below has been abstracted.

General Organization.—The basic organization of the department consists of a geographical division of the area of the city into three parts, each controlled by a division superintendent; a fourth division, under the control of the superintendent of incineration, directs the operation of three refuse-disposal plants and the department garages. The geographical divisions are divided into foremen's districts, each of which is subdivided into three sections, representing the days of collection; viz., Monday and Thursday, Tuesday and Friday, and Wednesday and Saturday.

Under this organization, the duties of the department are performed, which consist of, in general, the cleaning of public streets, lanes and thoroughfares, the collection and disposal of ashes and household waste material, the cleaning of catch-basins, the oiling of unimproved roadways and the removal of snow from the downtown section and main arteries.

During 1930 there were, on an average, 1,088 men employed daily in the various services of the department. The refuse-collection service required 28 city-owned trucks, 369 city-owned wagons, 65 hired carts and 14 hired trucks during the peak of the winter season, and was reduced to 26 city-owned trucks, 325 city-owned wagons and 31 hired carts during the summer months. Two hundred patrolmen and 52 vehicles were engaged in the street cleaning service. One hundred and nine men were engaged continuously at the refuse disposal plants.

Divisional Organization.—The divisional superintendents are responsible for the operation of their respective divisions. The execution of the work is entrusted to district foremen. Each superintendent is situated at the main yard of his division, where the time sheets are prepared, records maintained and reports made incidental to the operation of the division.

Each main stable is in charge of a stable foreman, and the sub-stable in charge of an assistant foreman, who is responsible to the superintendent for the care of horses, feeding, shoeing, wagon equipment and the condition of the stables.

Districts. — For refuse-collection purposes the area of the city is divided into 24 foremen's districts, which are subdivided into three sections, thus permitting a twice-weekly collection to all parts of the city. The average area of each district is 906 acres, with an average of 23.8 miles of streets and 6.4 miles of lanes. The boundaries of the three main divisions conform with those of foremen's districts. There are 11 districts in the eastern division, 8 in the northern division and 5 in the western division.

For the performance of street-cleaning work, there are five foremen's districts comprising the downtown business section, each district with an average of 1,700 acres and 51 miles of streets. The remaining section of 10 districts is under the jurisdiction of the refuse-collection foremen, who supervise the work in conjunction with the collection.

Yards.—There are three main stables and four sub-stables. The main stables and yards are centralized in each of the three divisions. The sub-stables are situated so as to serve the outlying sections and are under the control of the divisional superintendent.

The completion of the new stables and yards on St. Lawrence St. replaced the old yard at the Don Roadway and Eastern Ave.

Street Cleaning.—During recent years, street sanitation has attained its proper place in the wider fields of sanitation, and sanitarians realize that it is not by any means the least important part of that service rendered to the individual. The daily cleaning of a great city is by no means a small task, but is a problem involving the employment of a trained organization and the expenditure of a large sum of money.

The promiscuous littering of the streets by thoughtless citizens is perhaps the most difficult problem to contend with, while there is a city by-law prohibiting the throwing of waste upon the streets, and the overloading of vehicles to such a point that the material falls to the roadway, it is probably violated several hundred times a day without interference.

A newspaper carelessly discarded and separated by the wind will make a whole neighborhood appear relatively dirty, whether it is or not. Handbills, circulars and weekly district papers are invariably carelessly thrown upon verandas and steps, to the mercy of prevailing winds, and finally deposited upon lawns and boulevards, or lodged in shrubbery. It is estimated that 40 per cent of the litter found upon the streets comes from sources that are controllable.

Street dirt is divided into two general classes: natural, and therefore unavoidable, and that due to carelessness, therefore avoidable. The real duty of the department is the removal of the first class, but in so doing it is compelled to sweep up and remove the material of the second class.

The preventive side of street-cleaning work has in recent years been given particular attention, with a view to reducing avoidable litter to a minimum. The distribution of notice cards, detailing the various requirements of the by-laws and a closer relation with the department of public health, has attained results as well as stimulated the cooperation of the public generally.

The streets of Toronto are cleaned by the hand-broom method combined with flushing in certain areas. Machine cleaning has been adopted in many cities in conjunction with hand-cleaning, and has many advantages in the outlying or residential sections. It would provide a more rapid cleaning, thus affording more frequent cleanings in districts which are at present receiving only one sweeping per week, and further, it would release patrolmen in these districts for patrol work in congested business areas where street cleaning is limited to channel sweeping and paper picking.

During the summer season of 1930, 116,200 cu. yd. of street sweeping was removed from the streets, averaging 13.3 cu. yd. per 1,000 sq. yd. per season. A daily average of 25 4-yd. wagons, 18 2-yd. carts and 3 motor trucks was required in the pick-up service. Two hundred patrolmen were in daily service from April to December.

Each patrolman maintains an average of 3 miles of roadway, covering an area of 43,024 sq. yd. The downtown and business districts re-

TABLE I—COMPARATIVE TABLE OF PATROL SERVICE, 1913-1930

Year	Number of Patrolmen	Labor Weekly Wage	Expenditure	Street Mileage Improved	Street Mileage Total	Population
1913	428	$13.50	$270,653.00	336.47	521.53	445,575
1914	422	15.00	301,377.00	337.70	529.69	470,144
1915	395	15.00	301,787.00	359.21	530.24	463,705
1916	380	15.00	282,448.00	369.60	530.47	460,526
1917	192	18.00	183,111.00	372.10	530.63	473,829
1918	158	{20.00 {21.00	174,914.00	387.16	531.03	489,681
1919	215	24.00	253,442.00	384.61	531.03	499,278
1920	228	28.80	352,151.00	407.32	539.63	512,812
1921	190	28.80	308,155.00	401.34	545.89	522,942
1922	200	28.80	319,107.00	406.37	548.99	529,083
1923	130	28.80	222,868.00	430.71	556.17	538,771
1924	130	28.80	226,991.00	446.41	558.83	542,390
1925	158	28.80	265,851.00	458.82	559.94	549,429
1926	167	28.80	251,787.00	467.47	561.68	556,691
1927	175	28.80	262,939.00	477.02	562.16	569,899
1928	190	28.80	277,866.00	480.70	564.40	585,628
1929	195	28.80	270,399.00	506.30	571.30	606,370
1930	200	30.00	293,986.00	529.03	571.70	621,596

ceive constant attention, while the outlying or residential districts are swept once a week. The following tabulation shows the unit cost of hand-broom sweeping of improved roadways for 1930:

Total cost (foremen, labor, cartage, supplies)	$293,986.00
Area of improved street mileage (sq. yd.)	8,733,963
Cost of maintenance per 1,000 sq. yd. per season	$33.66
Amount of sweepings collected (cu. yd.)	116,200
Cost per cu. yd. (sweeping, collecting and removing)	$2.53
Cubic yards removed per 1,000 sq. yd. per season	13
Number of patrolmen	200
Average area maintained per patrolman (sq. yd.)	43,024
Average number of times swept per season	90
Cost of sweeping per 1,000 sq. yd. (sweeping, collecting and removing)	$0.37

Flushing.—Street flushing has two main functions: to prevent objectionable dust blowing about and to aid in the street-cleaning work. It is the best method for removing the fine dust and dirt which escapes the patrolman's broom. From a sanitation viewpoint, it is the only solution for thoroughly cleansing improved roadways.

During the past summer, four flushers were in operation, two of which are electric trucks and worked nightly in the downtown section. Two gasoline power flushers worked generally on main thoroughfares and areas where large excavations or construction work was in progress.

Road Oiling.—During the past summer season this service has been reduced 50 per cent over the preceding season, due to the enormous amount of improved roadways constructed during the year, particularly in the northern section of the city. The total cost of this service in 1929 amounted to $19,909.82, and was reduced to $9,890.81 in 1930.

The oil is applied by motor truck, which is equipped with a square steel tank with a capacity of 1,170 gal. It is applied cold by means of a 2½-in. perforated horizontal pipe, 8 in. from the ground and at the rear of the tank. The amount of oil used is based upon the condition of the roadway, while the flow of oil is controlled by a valve, operated by a conductor on the rear platform.

The oil is purchased in tank-car loads, which have a capacity of 5,000 to 8,000 gal. These tank cars are unloaded into storage tanks by a centrifugal pump, operated by a gasoline engine, which is capable of unloading a car of oil in two hours. There are four oil-storage tanks with a total capacity of 120,000 gal. From the tanks the motor truck is loaded by gravity, utilizing the tank nearest the district in which it is working.

Snow Removal.—The removal of snow from the public thoroughfares is performed by the Department of Works and the Department of Street Cleaning, each department having a defined area in which to work.

The total snowfall during the winter season, 1929-1930, amounted to 58.6 in. The maximum fall occurred on Jan. 17 and 18, when 5.4 in. of snow fell, while the mean temperature for the winter months, January, February and March, was 22.8, 26.8 and 31.1 deg. respectively.

Owing to the general all-year use of the motor vehicle, snow removal is now recognized as an essential public service, and every effort is made to keep the streets as free for traffic as possible, while during heavy snowstorms night crews are engaged to expedite the work, particularly in the business areas.

The disposal of snow, especially after heavy falls, presents its own problems. Sewer manholes are utilized throughout the city where possible, while the remainder is deposited on vacant land or ravine areas.

Toronto has 571 miles of streets, 529 of which are paved, with 200 miles of straight railway, single-track mileage.

TABLE II—STREET FLUSHING, 1919-1930

Year	Street Mileage Flushed	Quantity of Water Used Gal.	Total Cost	Cost per Mile
1919	1,670	8,546,750	$ 5,639.53	$3.44
1920	3,169	15,435,000	9,681.52	3.05
1921	3,834	20,591,900	12,606.80	3.29
1922	7,156	35,100,100	21,713.89	3.03
1923	3,865	22,267,300	13,781.95	3.56
1924	3,332	18,355,600	11,810.38	3.54
1925	1,702	10,830,950	6,225.94	3.65
1926	1,615	8,950,000	5,255.41	3.25
1927	1,294	7,173,550	4,195.93	3.24
1928	2,002	9,563,600	6,379.65	3.18
1929	2,740	15,229,000	8,427.82	3.07
1930	3,931	20,230,000	12,809.06	3.26

TABLE III—ROAD OILING, 1916-1930

Year	Mileage	Area Oiled	Quantity Used, Gal.	Total Cost Oil and Labor	Cost per Mile	Cost per 1,000 Sq. Yd.
1916	181.6	2,863,359	280,667	$22,772.69	$125.39	$ 7.59
1917	180.9	2,761,761	244,832	27,103.36	149.28	9.78
1918	108.2	1,743,612	172,997	22,057.33	203.84	12.65
1919	228	2,943,071	354,165	27,501.36	120.66	9.34
1920	201.6	3,353,660	253,716	46,886.65	232.13	19.49
1921	173.8	2,150,344	253,434	22,651.32	130.27	10.54
1922	244.2	3,147,237	361,945	33,468.56	149.28	10.11
1923	188.7	2,342,324	338,850	32,119.17	170.20	13.82
1924	164	1,886,838	295,300	28,004.56	170.34	14.84
1925	142.6	1,606,652	264,020	25,427.70	178.32	15.83
1926	136.9	1,613,569	244,673	23,639.97	171.81	14.65
1927	135.7	1,527,079	267,278	24,207.45	178.39	15.83
1928	139.1	1,578,409	294,130	21,322.12	153.29	13.51
1929	197	1,674,054	310,899	19,909.82	101.07	11.89
1930	73.1	758,320	143,320	9,890.81	135.30	13.09

Tests of TRUCK-CONVEYED CENTRALLY-MIXED *Concrete*

Conclusions important to the highway field developed by Lehigh tests —Only one type of conveyor used in study

PROGRESSIVE increase in strength with time of haul and absence of segregation are two characteristics of centrally-mixed, truck-hauled concrete observed in a series of tests conducted recently by W. A. Slater, research professor of engineering materials and director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa., and reported at the 34th annual meeting of the American Society for Testing Materials. These tests apply to hauls of from a few minutes to 2½ hours in a conveyor consisting of a closed rotating drum without mixing blades. An abstract of this report follows.

The operations took place on Dec. 29 and 31, 1930, in five separate runs designated as series A, B, C, D and E. The average and minimum temperatures for the working hours on these days, based upon data from the local station of the U. S. Weather Bureau, were: Dec. 29, average temperature 30 deg. F., minimum 26 deg. F. at 8 a. m.; Dec. 31, average temperature 28 deg. F., minimum 22 deg. F. at 8 a. m. Each of the first four series consisted of charging the conveyor with 2 cu. yd. of concrete, driving the conveyor around the streets for about 2½ hours and taking samples at intervals of about ½ hour. Each of these four series occupied about four hours.

Series E differed from the rest in that the conveyor was driven around with its charge of concrete for only 1 hour 15 minutes instead of 2½ hours and in that no samples were taken, either for determining the composition of the concrete or its strength. It was used principally for inspecting the appearance of the concrete in the drum and during its discharge. An additional test was made in which for comparison, samples of concrete were taken at intervals from a batch which was mixed in one of the mixers used throughout the test.

Description of Conveyor.—The conveyor consists of a truck upon which is mounted a cylindrical drum container of a rated capacity of 2 cu. yd. into which the concrete is placed through an opening in the surface of the cylinder, about midway of its length. This opening is provided with a watertight door sealed by a rubber gasket, occupying a groove in the lip of the opening. No leakage was observed during the rotation of the drum.

The drum is smooth on the interior and depends entirely upon friction of the concrete on the surface for any mixing action which may take place. The conveyor is not intended primarily as a mixer, but it is expected to provide enough agitation to prevent segregation of the concrete during transportation. During transportation the drum is rotated at about 8 r.p.m. by a mechanism which is independent of the truck drive, so that the drum may be rotated independently of movement of the truck.

The concrete is discharged through a door at the rear of the drum, and the drum is stopped with the discharge door at the bottom. In discharging, the front end of the drum is lifted by a power hoist which forms a part of the equipment, so that the drum is inclined at an angle of about 30 deg.

Materials.—In order to ascertain whether the consistency of the concrete at various times after mixing, or its strength, bore any relation to the time of initial set of the cement, seven different cements purchased in the market were tested for time of initial set, and the two (No. 1 and No. 7) which showed the longest and shortest times of initial set were selected for the test. The lengths of time required for initial and final set were:

	Initial Set, Minutes	Final Set, Minutes
Cement No. 1	178	337
Cement No. 7	140	322

Each value is the average of two tests. Cement No. 1 was used in series A and C, and cement No. 7 in series B and D. With cement No. 1, 1.6 per cent was retained on the No. 100 sieve, when the cement mixed with sand was screened in water.

The sand used was well graded and appeared rather coarser than the concrete sand generally used in the part of the country where the tests were made. The specific gravity of the sand was 2.68. Its weight when rodded dry into a 0.1-cu. ft. measure, was 109.1 lb. per cu. ft., and the voids under this condition amounted to 35 per cent. It had a fineness modulus of 3.15. About 3 per cent of it was retained on a No. 4 sieve and about 2.1 per cent passed the No. 100 sieve.

The gravel contained about 50 per cent of broken pieces formed by passing the larger pieces through a crusher. All of it passed a 1¼-in. sieve. The specific gravity of the gravel was 2.64. Its weight when rodded dry into a 0.1-cu. ft. measure was 97.9 lb. per cu. ft., the average for three tests. The voids in this condition amounted to 41 per cent.

Conduct of Tests.—Two small mixers were used for mixing the concrete. Eight batches, four in each mixer, were used for each charge of 2 cu. yd. This kept well within the manufacturer's rated capacity of the mixers. The cement and aggregates were used in the proportions of 1:2.33:4.15 by weight. Seven gallons of water per bag of cement were used, and the absorbed and surface moisture were included as part of this. The concrete was mixed 1½ minutes and as it came from the mixer the slump was about 8 in. It was discharged from the mixer into a dump bucket which was hoisted with a crane and dumped into the drum of the conveyor.

Every effort was made to mix the batches rapidly, in order that the length of time between the beginning of the mixing and the completion of the charging of the drum might not be too greatly in excess of that which occurs in commercial operation of the conveyor. The time required by the successive runs was: series A, 31 minutes; series B, 32 minutes; series C, 23 minutes; series D, 19 minutes.

Two runs were made on Dec. 29, series A starting in the forenoon with cement No. 1, and series B in the afternoon with cement No. 7. To secure confirma-

tory data, two more runs were made on Dec. 31, series C in the forenoon with cement No. 1, and series D in the afternoon with cement No. 7.

Methods Used in Testing.—The conveyor was charged with 2 cu. yd. of concrete, for which the quantities of the various constituents were definitely known. Samples were taken of the concrete as it came from the mixer just before it entered the conveyor, and at various time intervals after the conveyor had been charged and placed in operation. One set of samples was used to determine the slump of the fresh concrete and the compressive strength of the concrete after having been cured for various ages. Another set of samples was used to determine the composition of the freshly mixed concrete and thus to discover any tendencies toward segregation.

From each sample used to determine the compressive strength, three slump tests were made promptly after taking the samples, and then 18 6x12-in. cylinders were made, three to be tested at each of the following ages: 1, 2, 4, 7, 14 and 28 days. In general, complete sets of 18 cylinders each were taken at about 7 minutes after the conveyor was charged, and at intervals of 30 minutes thereafter, except that the last set, taken about 2½ hours after starting the drum, consisted of only six cylinders. As discussed herein, all the cylinders taken at any one of these times constitutes a "set." There were some exceptions to this routine. In the conveyor run, series A, 108 cylinders were made. In each of the runs B, C and D, 114 cylinders were made, making 450 cylinders in all.

Simultaneously with the sampling for compression specimens, other samples were taken for use in determining the constituents of the concrete. These latter samples (about 5,000 g. each) were taken directly from the stream of concrete as it was discharged from the mixer or the conveyor drum. The aim in these analyses was to separate the freshly mixed concrete into its constituents and to determine the amount of each by weighing.

The process used in determining the constituents was one developed by W. M. Dunagan, of Iowa State College, who was in charge of this work. The results of the composition tests help to ascertain whether there was segregation in the conveyor. It is believed that the accuracy of the determinations was sufficient for this purpose.

Compression specimens were cast in both steel and paper molds. The specimens tested at 1 and 2 days were stripped at about 24 hours, capped with plaster of paris or lumnite cement and tested without storage in the moist-room. The 2-day specimens stood in the open air of the laboratory for 12 to 24 hours before testing. The effect of this early drying probably was compensated for to some extent by the fact that all specimens were immersed and allowed to stand in water for about one hour just prior to testing. All other specimens cast in steel molds were stripped at 24 hours and placed in the moist-room. Those made in paper molds were placed in the moist-room at 24 hours with the molds still on. All specimens (except the 1 and 2-day specimens) were removed from the moist-room at a later date, capped with lumnite cement and returned to the moist-room later on the same day, except that of series A and B the 4-day specimens remained out of the moist-room a little less than a day and a half, and the 7-day specimens until the time of testing, or a little more than two days. The additional drying was partially compensated for by immersion just prior to testing.

The moist-room was kept generally at a temperature of 70 deg. F. From Thursday noon, Jan. 1, to Saturday night, Jan. 3, owing to trouble with the temperature and moisture control, the temperature averaged about 63 deg. F.

Constituents of Concrete as Determined by Tests.—Average results of the determination of the constituents of the concrete are plotted in Fig. 1. The accuracy with which each determination was made may be estimated from the uniformity in results of samples taken simultaneously. In series A, six samples were taken as the concrete came from the mixer. The water content determined from these six samples varied from about 1 per cent higher to 15 per cent lower than the amount of water used in the mix. The apparent cement content in these samples varied from about 12.5 per cent higher to 5 per cent lower, the sand content from 2 per cent higher to 18 per cent lower and the gravel content from 17 per cent higher to 4 per cent lower than the amount used in the mix.

It is noted in Fig. 1 that the amount of water determined from the analysis remained practically constant for the concrete kept in the conveyor for different lengths of time. The tests made on the samples taken from the conveyor show a variation in the amount of water from about 0.5 per cent higher to 3 per cent lower than the amount used in the mix.

The observed apparent cement content increased quite regularly during the time in the conveyor. It increased from about 2 per cent higher to 38 per cent higher than the amount used in the mix from the time the concrete was placed in the conveyor until the end of the 2½-hour period. This increase in observed apparent cement content must be due to an increase in the amount of very fine aggregate (passing the No. 100 sieve) during the rotation of the conveyor drum. This is confirmed by the fact that the observed apparent increase in the amount of cement was nearly equal to the decrease in the amount of sand. Evidently the mixing and churning action within the drum was sufficient to pulverize a portion of the ingredients until at the end of the run, the increase in the absolute volume of aggregate passing the No. 100 sieve amounted to about 36 per cent of the absolute volume of the cement. Such an increase in amount of fine particles would be expected to make the concrete appear richer,

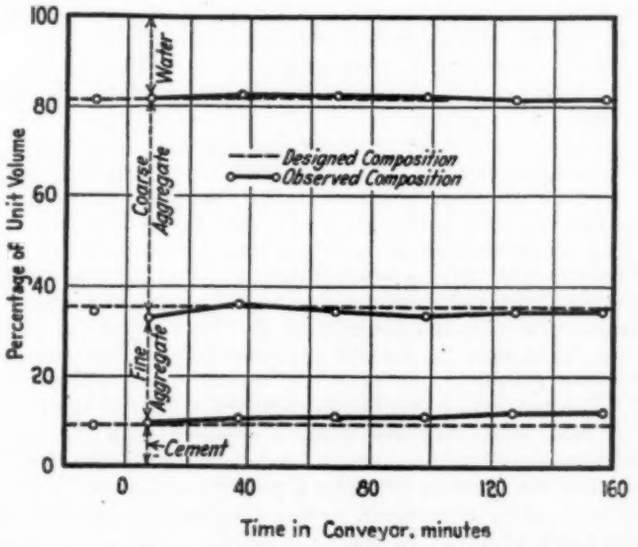


Fig. 1—Average Composition of Concrete from Conveyor, Four Series of Specimens

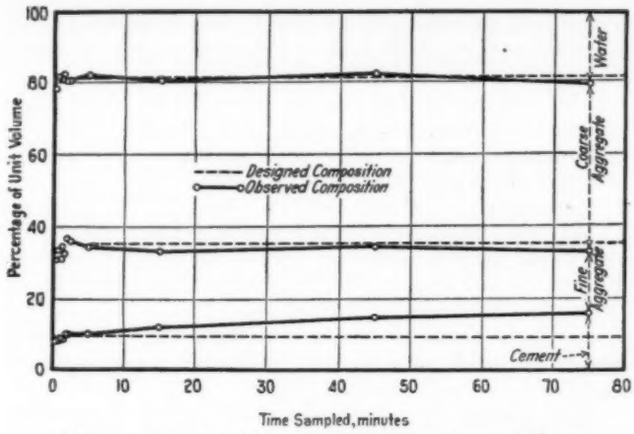


Fig. 2—Composition of Concrete from Mixer

to decrease the slump and probably to increase the strength of the concrete.

The average observed sand content varied from about 2 per cent lower to 14 per cent lower than the amount used in the mix. The sand content showed a general downward trend with the increase in length of time in the conveyor, but the results were not so consistent as the increase found in the cement content. The sum of the cement and sand had a slight upward trend, indicating that the quantity of material smaller than the No. 4 sieve increased during the time in the conveyor. The conveyor, therefore, seemed to have some grinding effect upon both the coarse and the fine aggregates. An increase in the amount of aggregate passing the No. 4 sieve would indicate only abrasion of the coarse aggregate, but the increase in the amount passing the No. 100 sieve could indicate pulverizing of both coarse and fine aggregates.

The average observed gravel content varied from about 4.5 per cent higher to 1 per cent lower than the amount used in the mix. The general tendency was toward a slight decrease in amount of gravel during the time in the conveyor drum. The line representing the sum of the cement, sand and gravel (see Fig. 1) is practically horizontal for the length of time in the drum. This indicates that the amount of solid materials in the mix remained constant, and adds to the confidence in the accuracy of the results obtained.

To furnish a comparison of the action of the conveyor drum with that of the mixer, a batch of the same proportion as those used in the conveyor was placed in one of the mixers and the mixer was run for 1 hour 15 minutes at the same rate as that employed in the mixing for series A, B, C and D. No slump tests or compression specimens were made. Samples for the determination of the composition were taken at intervals during the operation of the mixer. The results of these tests are given in Fig. 2, from which it will be seen that the sum of the cement and the aggregates remained practically constant. The water also remained constant within the limits of accuracy of the determinations. The apertures for charging and discharging remained open during the operation of the mixer, and there was no protection against evaporation. However, judging from the irregularity of the graph for amount of water, it appears that as much as 10 per cent of the water (about a gallon) could have been lost without being detected.

The apparent increase in the cement was even more marked than in the conveyor drum as shown in Fig. 1, indicating a greater pulverizing action in the mixer. Whereas in the conveyor the absolute volume of the aggregate which was pulverized sufficiently to pass the No. 100 sieve was about 36 per cent, in the mixer the corresponding quantity passing the No. 100 sieve was 72 per cent of the absolute volume of the cement, or twice as much as with the conveyor. Although the time of running the mixer was only about half as long as that of the conveyor drum, the rate of rotation was about twice as great, so that each made approximately the same number of revolutions.

The test was discontinued after 1 hour 15 minutes because the mix had become so stiff that the concrete stuck to the blades and could not be discharged from the mixer. It was supposed at the time that the stiffening was due, at least partly, to evaporation of the mixing water, but the results shown in Fig. 2 indicate that a more important factor was the increase in the amount of aggregate passing the No. 100 sieve.

The grinding in the conveyor and in the mixer was somewhat unexpected, but the results are consistent with each other. There seems to be no reason for suspicion of the results, but those for the mixer test should be used with caution, since no repetition of the test was made for the purpose of securing confirmatory data.

Consistency of Concrete.—Three slump tests were made on each of the concrete samples taken for each set of compression specimens; that is, at the time of charging the conveyor and at successive intervals after the concrete had been placed in the conveyor. The average results from all four series are shown in Fig. 3. On the first day of the test, the slump with both cements decreased faster during the first 30 minutes in the conveyor than during the remaining periods. On the second day of the tests, however, both cements showed a more uniform decrease in slump from the time of charging the conveyor until the end of the test. This difference may be due partly to the difference in weather conditions on the two days of the tests. On the first day there was a decrease in slump from about 8 to 1¾ in. during the total period in the conveyor, and on the second day a decrease from about 8 to 3 in. during the same period. The average for all series (plotted in Fig. 3) showed a uniform decrease in slump from about 8 to 2¼ in. during the time in the conveyor. This decrease in slump of the concrete during its stay in the conveyor may be due, partly, to the increase in amount of very fine material.

During the run, series C, the condition of the concrete in the conveyor was inspected at one of the sampling periods. This inspection was made by opening the "filler door" and observing the appearance of the concrete and its behavior when the discharge door was opened. The coarse aggregate appeared to be suspended uniformly in a fairly stiff mortar with no free water in sight. The consistency appeared uniform and there was no sign of segregation. When the discharge door was opened, the first appreciable movement of the concrete was quite general, but very slight over the greater part of the exposed surface. Soon a somewhat "cone-shaped" portion of the concrete broke away from the rest, due to the flow through the discharge opening. The sample received resembled closely the surface of the concrete in the drum as viewed through the filler-door aperture.

The visual inspection of the concrete at the time of taking each sample indicated that the concrete stiffened and gave the appearance of becoming richer and more plastic during its stay in the conveyor. The workability of the mix probably decreased less than is indicated by the slump test. In fact, as judged by the ease of plac-

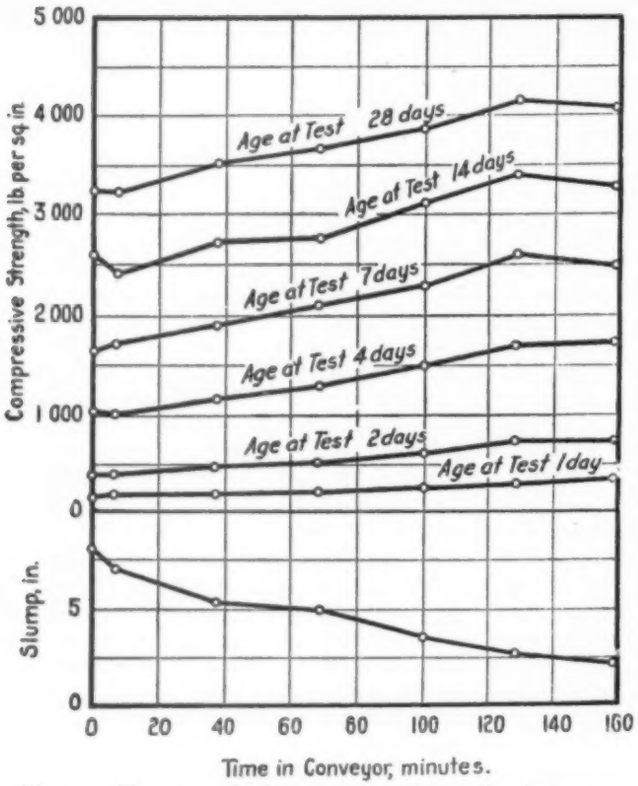


Fig. 3—Slump and Compressive-Strength Averages, Four Series of Specimens

ing the concrete in the molds, it was in general as workable at the end of an hour as when it came from the mixer and would be less subject to segregation in the forms. Series A showed unusual stiffness at the second sampling, that is, at 37 minutes. No other series showed so rapid stiffening, though the observation was that the stiffening was more rapid on the first than on the second day's run. Beyond the 1-hour period, up to the end of the run, the concrete remained plastic. It would require more work to place it in reinforced concrete construction, but for roads and pavements it seemed entirely adaptable. For the latter purpose it would be vastly superior to the concrete as it came from the mixer. To have secured directly from the mixer, with the same materials, a concrete of as good workability and as high strength as that which came from the conveyor after 2 hours of transportation, a higher cement content would have been necessary.

The difference between the lengths of time of initial set for the two cements had no effect on the behavior of the conveyor so far as such effect could be observed or measured in these tests.

Compressive Strength.—Three 6x12-in. cylinders from each sample were tested at each of the ages 1, 2, 4, 7, 14 and 28 days for each series. The average strengths for all series are given in Fig. 3. It is noted that the strength of the concrete at all ages increased quite consistently with the increase in the time the concrete had been in the conveyor prior to the taking of the samples. The average increase in strength from the time of placing the concrete in the conveyor until the end of the 2½-hour period was nearly 100 per cent for the 1-day tests, 90 per cent for the 2-day tests and about 80 per cent for the 4-day tests. For the 7, 14 and 28-day tests the increase in strength was nearly the same (700 to 900 lb. per sq. in.) as for the 4-day tests. That is, the time strength curves were practically parallel for ages above 4 days. The action of the conveyor had, therefore, a beneficial effect inasmuch as the concrete which remained 2½ hours in the conveyor had its strength materially increased. At least a part of the reason for this increase is probably to be found in the fact that the amount of very fine aggregate (amount passing the No. 100 sieve) increased considerably during the time in the conveyor.

Summary of Results.—The slump was generally about 8 in. as the concrete came from the mixer, but decreased very consistently during the time of retention in the conveyor drum. Even after 2½ hours in the conveyor, the consistency was such that the concrete could have been used quite satisfactorily for road or pavement work, where the requirements are especially rigid.

The amount of water and the sum of the absolute volumes of the cement and aggregates remained practically constant throughout each run. The amount of cement, however, appeared to increase. As this apparent increase was about the same as the decrease in the absolute volume of the sand, it is likely that it was due to the pulverizing of the aggregates, especially the sand.

The apparent increase in cement content in a batch of concrete mixed in the mixer for 1 hour 15 minutes was much greater than that in the drum of the conveyor and the stiffening of the batch was correspondingly more marked.

There was no indication of segregation of the concrete in the conveyor drum as observed visually, or as determined by testing the composition of the concrete.

The strength of the concrete from samples taken at successive intervals after charging the conveyor drum increased progressively according to the length of time of transportation.

The difference between the lengths of time of initial set of the two cements used had no effect on the results, so far as such effects could be observed or measured in a test of this sort.

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Pennsylvania to Build Low Cost Roads to Relieve Unemployment

Plans for the immediate improvement of 236.72 miles of light-type highway have been announced by Samuel S. Lewis, secretary of state highway department. This work will be started by the department to relieve unemployment.

Road sections in 53 counties are scheduled for improvement under the program. This highway work will cost approximately $7,500 a mile. The department during the summer plans the improvement of more than 500 additional miles.

All this mileage is on roads that are already part of the highway system. Mr. Lewis states:

"Work on this program will start at once and as much local labor as possible will be employed. Our men will go out into each community in which these projects are carried on and hire local labor on the spot, which is a guarantee that local labor will be employed. The only labor not local will be the superintendent and possibly one or two skilled mechanics. In the latter case, skilled mechanics will be employed locally when found practicable.

"In addition to giving isolated farms direct communication over improved roads with market, rail and shopping centers, these roads will provide access over improved roads to public schools, churches, cemeteries, grange halls, postoffices and crossroad stores. These roads, too, will serve to improve and facilitate postal communications."

Recent Books

Surveying

ROUTE SURVEYING, by George W. Pickels, C. E., Associate Professor of Drainage Engineering, University of Illinois, and Carroll C. Wiley, C. E., Associate Professor of Highway Engineering, University of Illinois. First edition; 380 pages; 4¼ in. by 6¾ in.; flexible binding. John Wiley and Sons, Inc., New York, publishers. Price, $3.50.

This book is really a revision of the authors' work a "Textbook on Railroad Surveying." The revision includes some discussion on highway pipe line, transmission line and canal line surveys. Although the fundamentals of surveying are the same no matter what the type of construction, yet there are pecularities typical of each kind of survey. The material included in this book on surveys other than railroad surveying is of a very general nature.

Railroad location and surveying for route is adequately treated and problems included so that one may clinch his study by solution of problems.

Drafting for Map Work

MAPPING AND LETTERING, by Malcolm Lloyd. First edition. 58 pages, 10¾ in. by 7¾ in., fiexible fabrikoid binding. P. Blakistons Son & Co., Inc., 1012 Walnut St., Philadelphia, Pa., publisher.

This book is a discussion of practical employment of drafting and lettering for map work with idea in mind of promoting more artistic designs and presentations. As considerable practice and skill are required to produce what the author considers well executed plans it is doubtful if most commercial organizations would take the time necessary to arrive at the standard suggested by the author. Many practical limits and methods are discussed. The various charts included show the steps of execution quite clearly as well as results to be desired.

Employing Estimating Curves

ESTIMATING CONSTRUCTION COSTS, by G. Underwood. First edition, 620 pages, 6 in. by 9 in., flexible imitation leather binding. McGraw-Hill Book Co., 370 Seventh Ave., New York, N. Y., publishers. Price, $6.00.

This book has been designed on one idea. That idea is the presentation of estimating data by employing similar line drawings. In order to draw up a curve on any data at least two sets of facts must be known about the curve data. In most cases in this book, the two sets of data known are the cost per day, in dollars, for the labor (or material) and the assumed rate of labor. From these a curve is drawn and the ordinate numbered in cost per unit. For general checking of some kinds of work these approximate results may be employed. Because of the fact that no two men can produce the same result on the same job, or the fact that no two foremen can get equal results with the same crew, the curves cannot be used for accurate estimating. Local conditions and job conditions are too influential factors in results to be able to classify them by a curve representing quantitative results as curves of certain specified time lengths.

However, the curves are useful in giving one a general idea of the average results that may be secured by average men working at average rates of speed.

The subjects are treated in the following order:

Introduction, Transportation of Materials, Handling Materials, Excavation, Piling, Concrete, Wood Construction, Brick, Tile, and Stone; Structural Steel, Lathing and Plastering, Roofing, Flashing and Waterproofing; Pipe Work and Heating, Plumbing, Electrical, Painting and Glazing, Machinery and Machinery Erection, Overhead, Estimating, Prices of Construction Materials.

Plant Limitations Explained

DETAILING AND FABRICATING STRUCTURAL STEEL, by F. W. Dencer, C. E., Ass't. Division Engineer, American Bridge Company. Second edition, 441 pages, 5¾ in. by 9 in., cloth hard binding. McGraw-Hill Book Company, 370 Seventh Avenue, New York, N. Y., publisher. Price, $5.00.

In this work the author has included a discussion of engineering and shop organizations for fabricating and utilizing structural steel, a study of structural designs and specifications, handling contracts, ordering materials, making shop drawings, inspecting and shipping steel. The operations of the several departments of a fabricating plant are described in some details. It represents an important link between the theory and practice of structural designing. Too much weight can not be placed upon this type of book; one which explains to draftsmen and designers just what are the limitations and capabilities of fabricating plants. Books of like character would be well utilized in the field of general construction.

Arcs, Chords and Versines

TABLE FOR USE IN COMPUTING ARCS, CHORDS AND VERSINES, by Harry Clow Boardman, C. E.; member Am. Soc. C. E. First edition, 32 pages, 5¼ in. by 7¼ in., paper cover. Chicago Bridge & Iron Works, 1305 W. 105th St., Chicago, Ill., publishers. Price, $1.00.

This 32-page book has just been published by the Chicago Bridge & Iron Works. The range of this table, which is intended for use with the squares and logarithms of Inskip and Smoley, corresponds to central angles between 0 and 60 deg.

Those having occasion to work with problems involving arcs, chords and versines will find that this table eliminates a large amount of tedious work.

Highway Transportation Economics

HIGHWAY ECONOMICS, by Sigrald Johannessen, Engineer of Design, New Jersey State Highway Department; Mem. Am. Soc. C. E.; Inst. of C. E.; Danish Soc. of C. E. First edition, 157 pages, 5¾ in. by 9 in., cloth hard binding. McGraw-Hill Publishing Company, New York City, publishers. Price, $2.50.

An engineer engaged on the design or construction of a bridge railroad, or other engineering project is sometimes inclined to look upon the work on which he is engaged as the finished product. This is natural and proper to the extent that, once decided upon, the project is a unit in itself with its own technical and economic problems to be solved. McCullough's Economics of Highway Bridge Types is a fair example of this type of highway transportation problem as a whole. It is, however, a definite detail that must first be solved before the problem as a whole can be tackled.

This book is a study of the problem as a whole and is commendable in that specific examples are given with definite figures assigned to the various details in order to guide one's judgment toward a correct solution.

Studies of FROST HEAVES *in Michigan*

Field Studies Laboratory Work Practical Applications

By A. C. BENKELMAN
Research Engineer, Michigan State Highway Department

IN 1925 the Michigan State Highway Department began a comprehensive study of the condition of concrete pavements throughout the state in order to determine if possible those subgrade factors which were chiefly responsible for the annual damage from sources which were in no sense related to either design or loading of these pavements. Concrete pavements were chosen because they are composed of a single material with properties reasonably well known, and because developed defects can be readily recognized and easily classified.

The late Victor R. Burton has suggested in a discussion of soils and their relation to road structures that failure of pavements when due to the subgrade on which they rest is wholly a phenomenon of soil movement, either vertically or laterally, or both. Vertical movement comes from two major sources, from the plastic flow of soils either in or beneath the subgrade and from expansion due to frost action. Both of these forms of soil movement have been the subject of considerable investigation in Michigan during the past few years.

The problem of fill settlement on peat marshes was first attacked because the damage suffered was much more obvious, and research has very well settled on its cause and cure. Results from the pavement survey mentioned indicate that about 33 per cent of unsatisfactory pavement is due to settlements obvious enough to be plainly visible to the pavement surveyor. Some of this damage is due, of course, to the settlements of high fills resting on mineral soils.

Damage from Frost.—The most important soil movement in Michigan is caused from frost action resulting in damage to pavement structures both from rupture due to differential expansion of subgrades on freezing and from settlement subsequent to thawing. This class of damage accounts for something over 50 per cent of pavement the condition of which is classed as unsatisfactory. In our studies the condition of pavement is considered to be unsatisfactory when the size of developed pieces is less than 10 sq. yd. Taking both causes into consideration, there is roughly between 75 and 80 per cent of unsatisfactory pavement five years or less in age due to these two forms of soil movement. The total percentage of yardage which is classed as unsatisfactory, of course, increases with age. Percentages shown on the survey vary from 1.5 per cent the first year to 2.9 per cent at two years, 4.5 per cent at three years, 5.3 per cent at four years and 6.5 per cent at five years.

It is fairly well established that the mere incorporation of reinforcement in pavements or added thickness of slab will not ordinarily prevent failures caused by differential frost heaving or resulting settlement in the subgrade. A realization of these facts has emphasized the necessity of procuring sufficient knowledge by thorough research of the phenomena of frost action and fill settlement in subgrade soils as it is felt that the remedy for this damage lies in a correction of subgrade deficiencies rather than change in design of pavement surfaces.

Field Investigations Begun.—In order to investigate fully the problem of frost action, both laboratory and field studies were started. During the winter of 1928-29 frost heaving was unusually severe and ample opportunity was afforded for a study of these phenomena. In February, 1929, field engineers of the department were requested to secure certain information as to the location and extent of all the major disturbances in their respective divisions. The exact limits of each heave were staked out in the field and the location as staked was shown on maps forwarded to the main office so that the heaves might be easily located for future study. Over 500 heaves were located in this preliminary survey, and during the following two summers detailed examinations were made of about 150 of these locations. Field examinations of the soil at the site of heave were made by trained soil men who not only investigated the soil itself, but prepared sketches which showed the condition of the road surface, grade of the road, depth of cut, direction of surface drainage and all other factors which were considered to have any bearing on the problem.

The subgrade soil surveys started, also in 1925, have been consistently carried out by trained soil surveyors using the Bureau of Soils profile nomenclature. Soil profiles are identified by these men wholly by visual inspection and "feel" of the texture. The field studies of frost heaving were accordingly carried out in this same routine way. Laboratory work has been confined to a study of freezing phenomena on the materials identified by soil survey, although mechanical analysis of the textures investigated were made as a check upon the identification.

The field investigations to date have covered only the most severe disturbances. It is entirely possible that while small in extent the mere difference in expansion on freezing two or more adjacent soils which are radically different in texture could easily cause abnormal cracking in concrete pavements. So far as any injury to the road surface is concerned it is probable then that there are many minor disturbances whose effect on pavement structure may be quite as serious as the larger heave whose effect is so plainly apparent.

Michigan, being a glaciated state, is particularly unfortunate in containing many soils which are conspicuous for their lack of uniformity in texture. Certain soil profiles show all variations from clay to gravel throughout the 4-ft. depth of profile considered on a soil survey. It must not be thought, however, that soil as indicated by a particular type of profile is the cause of frost heaving, because, as will be shown later, most

of the frost disturbances occur in the parent material below the weathered zone comprising the standard type of profile. Within the soil type itself the cause of heaving is due, of course, to definite associations of materials favorable to this phenomenon.

Dangerous Soil Types.—It is, however, plainly apparent from work already done that a comparatively few soil types are particularly dangerous because of the variations in texture commonly found in the parent material. It was apparent early in the investigation that morainic soils were by far the most prolific sources of frost trouble. In addition, certain soil types within the general classification of soils of morainic origin were particularly frequent offenders. This is especially true of soils which we know as Bellefontaine, Coloma and Miami.

A classification of frost heaves occurring in different soil types shows that these disturbances occur according to geological origin in the following order:

Type	Per Cent
Moraine	65
Shallow outwash	15
Till plain	12
Lake bed	4
Deep outwash	4

As was stated before, it is quite apparent that by far the larger number of frost disturbances are in morainic soils with the next frequent occurrence in what is generally known as shallow outwash. This shallow outwash may not, however, be true outwash plain, because in certain instances what is termed outwash may be windblown sand over an old clay lake bed. It does, however, mean that there is a comparatively thin layer of sand overlying a heavier material. Frost heaves noted in till plain are very frequently not in the true geological till material but are often in a cut which goes completely through the till of one glacial period into an old ground moraine of a preceding glaciation. Lake bed and deeper outwash are comparatively free of soil textures which cause serious trouble from frost heaving.

Of the 65 per cent of heaves occurring in moraines, 65 per cent of these in turn are confined to the soil types already mentioned, namely Bellefontaine, Coloma and Miami, and their occurrence is about equally divided between the three. It is therefore necessary in soil-survey work for correction of subgrade deficiencies due to the occurrence of frost-heaving textures, to pay particular attention to these three types. While heaving occurs in other types of soil, yet it is comparatively infrequent as compared to those types singled out as being particularly subject to this type of disturbance.

Conditions Favorable to Heaving.—It is quite definitely indicated from the information disclosed by the field studies that a layer or pocket of fine-textured material surrounded by a coarser, better drained soil is a condition favorable to the development of frost heaves; also, that where a relatively small area of silt or very fine sand outcrops in a loam or clay soil, trouble from frost heaving is apt to develop. It is definitely indicated, further, that heaves are very likely to develop in medium to fairly coarse sands in which the water table is abnormally high or where an underlying impervious clay layer cuts off the downward movement of gravitational water. Also, that heaves may occur where water is fed under pressure to moderately coarse soil textures.

A detailed analysis of the cause and effects of the 156 heaves examined in the field showed that 94 occurred in a layer or pocket of fine-textured material such as silt, very fine sand and silt, silty clay, clay or sandy clay surrounded by coarser, better-drained material; 22 occured in a pocket of silt or very fine sand and silt surrounded by clay; 30 occurred in medium to fairly coarse sand, and 6 occurred in moderately coarse textures. The remaining 4 of the 156 heaves occurred where the subgrade soil appeared uniform with respect to character and moisture content.

In regard to the 94 heaves which occurred in finely-divided soils, study showed that 5.3 per cent of this number developed in silt, 32 per cent in very fine sand and silt, 4.3 per cent in very fine sand, 30 per cent in clay, 8 per cent in silty clay and about 17 per cent in sandy clay. For the 22 heaves which occurred in finely-divided textures surrounded by clay, 45 per cent of the number developed in silt, 23 per cent in very fine sand and silt, 18 per cent in silty clay and 14 per cent in sandy clay. Of practical significance was additional information disclosed from these studies which showed that the average length of deposit of these finely-divided textures was somewhat less than 60 ft.

In regard to the vertical extent of the heaves, data furnished by the field engineers showed that generally the upheaval was greater where silt was involved. The height was somewhat less for sandy clays or loams than for clays. The average height for all the heaves occurring in silt was 6 in., in very fine sand and silt 5 in., in very fine sand 4 in., in clay 4 in., in silty clay 5 in., and in sandy clay 3 in.

In the case of the heaves studied, 80 per cent occurred in cuts, 2 per cent on fills and 18 per cent on locations extending from cuts to fills. For the 500 heaves located in the preliminary survey, 76 per cent occurred in cuts, 10 per cent on fills and 14 per cent on cut-to-fill locations. For the 141 heaves studied in cuts, 80 per cent were located at a depth of 4 ft. or more from the original ground-line elevation.

Practically, the knowledge gained from the studies discussed in the foregoing paragraphs suggests the possibility on new work of locating, in the great majority of cases, associations and conditions of soil textures which cause excessive frost disturbances. In this connection it is felt that this applies particularly to silt textures. Invariably this grade of soil exists in a wet although stable condition, unless manipulated, even during periods of drought. Furthermore, information obtained from 200 miles of general soil work this past summer shows definitely that trouble from frost action unquestionably occurs wherever this grade of soil prevails. On the other hand, however, it was found that excessive heaving does not always occur in clay or sandy clay pockets even when surrounded by sand, an association of disastrous proportions where silt is involved. If clay or sandy clay pockets are quite far removed from sources of water, the chances are that no serious trouble from frost action will occur. It is in some cases, then, largely a question of judgment where clay or sandy clay is involved but never in the case of silts.

Laboratory Investigations Begun.—In 1928, in order to study the phenomenon of frost heaving, a cold room, 9x12 ft. in size, was built in the state highway department laboratory at the University of Michigan, in Ann Arbor, in cooperation with the civil engineering department of the university. Temperatures in this room are controlled automatically so that it is possible to maintain a temperature within about 2 deg. between the limits of 0 to —35 deg. C. An air lock is provided between the laboratory itself and the cold room proper so that entrance to the freezing chamber is never made directly from the warm air of the laboratory. Investigations planned for this room had only fairly begun

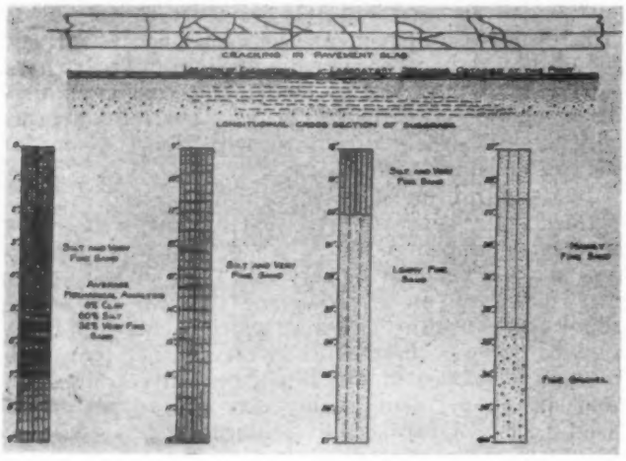

Fig. 1—Vertical Profile of Frozen Subgrade Showing Presence of Ice Layers

before the classic experiments of Professor Taber at the University of South Carolina eliminated the necessity for certain work and pointed the way to the desirability of still further study in other directions.

Taber's experiments had quite definitely indicated that ice segregation in soils was restricted to clays or material of a similar particle-diameter size. Our field investigations on the other hand had disclosed the fact that by far the most serious disturbances occurred in silts with an ice formation or banding very similar to that described in Taber's experiments for clay. It was felt that perhaps the size of sample used by Taber might have considerable to do with the results obtained because of possible radiation losses in specimens of small size. Very large specimens were therefore used which had actually been cored out from known frost-heave locations.

Initial Experiments.—The initial freezing experiments were conducted on undisturbed specimens of soil 3 ft. long and 1 ft. in diameter. These specimens were obtained by forcing a split steel cylinder into the soil by means of a hydraulic jack and superimposed truck load. Four specimens of this size were frozen, two of which contained an inserted porous layer of gravel. They were installed in specially insulated wooden containers, with provisions for supplying heat and water in any desired quantity to the bottom of the soil columns. Periodic measurements of the temperature and rate of freezing were obtained by means of thermocouples which were installed at different points in the soil.

These specimens were obtained as noted before from locations in the field where particularly serious heaves had been active for a number of years. Attempts had been made to correct the condition in the case of one of the disturbances by an extensive system of lateral tile drains and transverse bleeders without any visible success whatsoever. Also, an excavation had been made along the edge of the pavement when the subgrade was frozen that revealed the presence of a profusion of ice plates in this material. A sketch was prepared showing the position and thickness of the ice formations, which is reproduced in Fig. 1. The total heave at the point of excavation was about 8 in.

These specimens were frozen, then thawed and refrozen with the development of only a slight amount of vertical expansion. On examination of the frozen material after test it was apparent that this expansion was due to the simple freezing of the soil and not to the formation of ice layers. These results led to the opinion that natural freezing conditions in the field were not reproduced in the laboratory tests. Of course, in nature the rate of freezing obviously varies to a marked extent while in the cold room the temperatures were controlled to within a very few degrees. It was decided at this time to construct a special freezing chamber whereby specimens might be frozen at a variable rate of cooling in order that conditions in nature might be more closely stimulated. Several interesting facts were established by these experiments, which are as follows:

1. Water in the form of moisture vapor may be transferred through a material with a large void space when freezing takes place above. (The moisture content increase in the material existing above the gravel layers was approximately 10 per cent.)
2. Silt when highly saturated may lack sufficient stability to support unbonded stone or gravel layers. (In case of one specimen the gravel cut-off completely disappeared into the material beneath. See Fig. 2.)
3. Frozen soil may thaw from underneath as well as from the surface downward because of atmospheric temperature changes. (An increase in the cold-room temperature in one instance from —30 to —23 deg. C. raised the freezing line in the soil specimen about 4 in.)

Experimental Development of Ice Plates.—Later experiments in the laboratory involved further attempts to develop the formation of ice plates in those silts in which excessive heaving had developed in the field. Test samples were prepared for freezing in several diffent manners and in containers of various types and sizes. A series of specimens was prepared by dispersing a definite quantity of silt in water and permitting the material to settle out into glass tubes 8 in. in height and 65 mm. in diameter by the use of a funnel-shaped

Fig. 2—Frozen Silt Cylinder Containing Inserted Gravel Cut-Off. Hoar Frost Formed in Void Space Created by Settlement of Gravel into the Wet, Soft Material Beneath

Fig. 3—Glass Tube Containing Graded Frozen Silt Specimen. Segregation (Upper Part of Tube) in Material Having a Particle-Diameter Size Less than 0.005 Mm.

container. This gave a graded specimen of the material, the coarser particles existing at the bottom and the finer at the top of the tube. Other samples were prepared by tamping the material into tubes, and setting them upright in water until the soil at the top became moist. A series of each of these samples was first frozen in an oil bath, provisions being made to supply heat and water to the bottom of the tubes. Later on, similar specimens were frozen in a special freezing chamber in which the temperature could be held constant and at any desired level, so that freezing took place from the top downward.

In case of the specimens prepared by dispersion and deposition into glass tubes, it was found on freezing at a constant rate that ice plates invariably developed in the upper part of the tube or in that portion of the material having a particle-diameter size less than 0.005 mm. (See Fig. 3.) Only a form of microscopic segregation occurred in the case of silt specimens prepared in other ways. However, after a series of the latter had been frozen, several were thawed from the bottom up and a break or void in the soil followed the thawing line which gradually increased in width as thawing progressed upward. This void filled with water, and on refreezing before the thawing line had reached the top of the specimen, this water was converted into a pure ice layer. A second ice layer was later developed below the first in a similar manner. (See Fig. 4.)

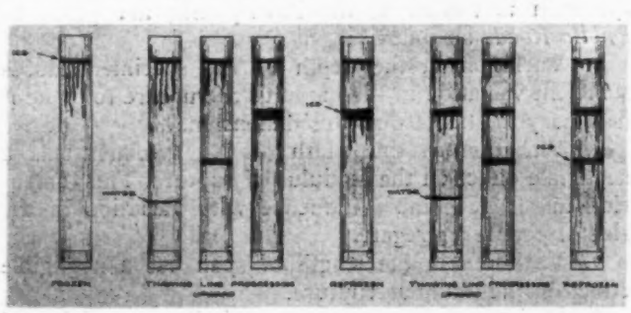

Fig. 4—Development of Ice Layers in Silt From Alternate Freezing and Thawing Below Surface

It was possible to remove the glass tubes containing the specimens from the freezing box and observe developments at any time. As the thawing line progressed upward, the individual silt particles were released from the frozen mass above and could be seen settling down through the clear water layer to the unfrozen soil beneath.

The possibility that fluctuations in the air temperatures during the winter months may cause a shifting vertically of the frost line in the ground was clearly indicated from a study of the temperature movements in the freezing experiments on the large soil columns. In one instance the ammonia pumps broke down and a gradual rise in the freezing-room temperature from —30 to —23 deg. C. over a period of two days occurred. This resulted in a shifting of the freezing line toward the surface from a depth of about 12 to 8 in. In nature, of course, the depth of frost penetration is more than likely a decided variable, the extent depending upon local variations in soil character and texture, amount of moisture present in the soil, etc. Fluctuations of the air temperature in turn promoted thawing to unequal degrees beneath the surface, which in all probability results in a very irregular vertical profile of the thawing or freezing line. When soils freeze, expansion takes place in proportion to the amount of water present. If thawing then occurs from underneath, the frozen material will suffer a decrease in volume in proportion to the amount of expansion that has occurred and voids of variable dimensions and variable distances from the ground surface may develop. Water liberated fills the voids and then freezes at subsequent downward movements of the frost line. A number of repetitions of this phenomenon could easily cause excessive heaving.

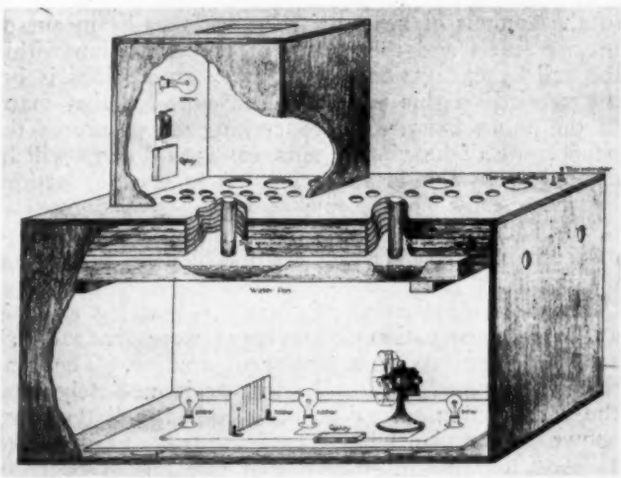

Fig. 5—Temperature-Control Freezing Boxes

Results obtained from experiments recently completed in the laboratory have proved conclusively that excessive heaving in silts is due to the phenomenon described above. Ice plates, together with considerable uplift, developed in specimens frozen at a variable rate of cooling, while duplicate specimens frozen at a constant rate suffered only minor changes in volume without the formation of ice plates.

Freezing Apparatus.—The freezing apparatus developed for these experiments consists of two compartments, one of which is superimposed upon part of the

other. An automatic time-control mechanism effects a periodic fluctuation of the freezing temperatures in the upper compartment. Specimens prepared for freezing are then inserted in holes cut through the top of the lower box and those covered by the upper chamber may be frozen at any desirable non-uniform rate, while those whose tops are exposed directly to the air of the cold room freeze at a constant rate of cooling. (See Fig. 5.)

Silts, Sands and Clays.—It is noteworthy and significent that Taber in his laboratory studies of the freezing and thawing of soils never obtained appreciable segregation of ice in soils having a particle-diameter size larger than 0.006 mm. The majority of silts in which frost disturbances have occurred under roads in Michigan contain from 10 to 20 per cent clay, 60 to 80 per cent silt and 20 to 30 per cent fine sand and sand, or an average of 70 per cent of such textures has a size range from 0.005 to 0.010 mm.

It is also significant that no difficulty has been experienced in promoting the formation of ice plates in clays and silty loam soils, a few specimens of which were frozen at a uniform rate of cooling simultaneously with the silt specimens. Marked segregation invariably took place in these materials regardless of the rate of freezing, the method of preparation of the specimens and the type or size of the containers. Here, of course, the ice plates were formed by the movement or addition of water to the point of freezing, the nature of their formation corresponding to that described by Taber.

A series of field studies embodying the determination of the amount of heave of road surfaces by means of precise levels and the nature of the expansion within the soil by excavations and visual examinations is being carried on this winter. It is expected that many of the points in question concerning the nature of the phenomena of heaving in silts, sands and clays will be cleared up by this investigation. A total of 20 stations has been established, some at locations where severe disturbances have occurred and others in soils of a questionable character and yet in which no trouble has developed.

Practical Application of Results.—Starting early in 1930 pre-construction soil surveys were made on all pavement projects as a matter of routine. The road line is examined by a soil surveyor immediately after the construction survey is made and all soil types are shown on the plan when it is drawn up. Construction features involved in grade design, methods of drainage, subgrade treatment, etc., are considered in their relations to this soil information and plans are drawn accordingly. Due to the detailed study of soil formations necessary to locate areas liable to frost heaving it is necessary for the soil men to visit the jobs from time to time during the course of grading and inspect the subgrade carefully when it is exposed to view. Subgrade treatment and drainage measures previously recommended are reviewed and checked and any changes deemed necessary from the information disclosed by the detailed study are ordered and made.

Silt pockets, wet clay areas, saturated sand layers over clay and areas affected by seepage are definitely located and then measures are applied for the purpose of eliminating or reducing frost heaving. Inasmuch as little doubt exists concerning the invariable tendency of heaving in silts, silty clays and very fine sands, these materials are generally removed from the grade and replaced with a proper material. The depth of excavation in the work done to date has been varied in some cases as a matter of experimentation, although this now is governed largely by the location in the state, north or south, and the length of the deposit. In a few instances where unusually long deposits of these textures were encountered it was found more economical to raise the pavement grade than to excavate and replace the material with a satisfactory grade of soil. Inasmuch as the majority of these undesirable textures, as brought out before, prevail in the subsoil of sandy moraines it is simply a question of wasting the excavated material and using the surface soil for backfilling purposes. In some instances tile drains were installed in addition to removal and replacement of the material. This added precaution was taken in the cases where silt or very fine sand pockets were surrounded by clay and coarser material was used to replace the objectionable type of soil.

In case of pockets of wet clay areas surrounded by well drained sand or layers of wet sand over clay, steps are taken to intercept possible sources of lateral seepage water and to lower the ground-water level by systems of tile drainage. In view of the lack of definite information obtained in the field studies concerning the occurrence of frost heaves in clay, the removal of this type of soil and substitution of an unquestionable material does not yet seem to be justified.

In all, about 200 questionable locations in the grade of new paving projects were accorded some form of special treatment during the construction season of 1930. Special drainage structures were installed at approximately 125 of these locations, while in most of the other cases the material in question was removed and replaced with a suitable soil. It is anticipated that a great deal of interesting and useful information will be obtained by observing developments at the locations where these special subgrade design measures were applied.

Acknowledgment.—The foregoing is a paper presented Feb. 19 at the 17th annual Conference on Highway Engineering at the University of Michigan.

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Size and Flexural Strength of Concrete Specimens

In attempting to standardize the methods and apparatus for making flexural tests of concrete, a committee of the American Association of State Highway Officials has been carrying out experiments on the effect variation in the dimensions of the test specimen has on the modulus of rupture, as determined with the apparatus recently designed for the committee. The conclusions, restricted in their application to apparatus in which the specimen is loaded at the third-points, are given in *Public Roads* as follows:

1. Variation in the depth of the specimen causes sufficient variation in the modulus of rupture to make it necessary to standardize this dimension.
2. Variation in the width of the specimen has a negligible effect on the modulus of rupture. This dimension might have more influence with variation in the size of coarse aggregate.
3. Variation in the length of span has a negligible effect on the modulus rupture.
4. Different laboratories using similar materials and methods of tests can check each other with a variation not exceeding 5 per cent.

Highway RESEARCH *Abstracts*

EVERY research agency has in its file many reports containing research data which for one reason or other are not extensively published, but which should be of great interest to other workers if they knew of their existence. The Highway Research Board of which R. W. Crum is director and Fred Burggraf research engineer, frequently receives copies of such information and has decided to distribute from time to time, through its Research Information Service, abstracts of all such reports that it has at hand. The first circular of the series issued in May contains the following abstracts.

The Effect of the Gradation of Coarse Aggregate on the Density and Strength of Concrete.—D. V. Terrell, professor of civil engineering, University of Kentucky.

Results of two series of tests are given. The first series contained eight different gradations of gravel. The water-cement ratio was kept constant at 0.77. The mixes were designed to have a cement factor of 1.4 and to have enough sand to overfill the voids in the coarse aggregate to 25 per cent. The second series contained three different gradations of both gravel and crushed stone. Water-cement ratio was kept constant for the gravel at 0.77 and 0.83 for the stone. Tests made to determine slump, density and compression strength of concrete.

As far as these data are concerned, Professor Terrell concludes that the gradation of the coarse aggregate does not affect the density or strength, but that slump is affected. Also that one size of aggregate if larger than 1 in. is not satisfactory and that density decreases as the water content increases.

Contracts Let for Excavation and Backfilling Jobs as a Means of Preventing Frost-Heaving on Routes to Be Paved This Year.—Minnesota Highway News, Jan. 4-11, 1931.

Five contracts totaling 125,000 cu. yd. of excavation at a cost of $93,347 were let by the Minnesota Highway Department as a means of preventing frost-heaving. This includes excavating the undesirable type of soil and backfilling with suitable material. The amount of excavation on these jobs varied from 9,000 to 44,000 cu. yd. Interesting and useful information will be obtained by observing developments at the locations where these special subgrade design measures were used.

Hot Aggregates, Their Effect on Concrete.—Minnesota Highway Department.

The aggregates and water in these tests were heated to give batch temperatures of 70,100 and 130 deg. F. when discharged from the mixer. The temperature of the mixing water was considered most important on account of its higher specific heat. To obtain the same workability, as measured by the flow table, it was necessary to add more water to the warmer mixes. The concrete specimens were tested by compression and cross-bending. Time of set was determined by making several flow specimens and testing them at different intervals. The results showed that the warmer the concrete, the more rapid the setting. Strength tests (3, 7, 14 and 28 days) showed that strength decreased as the temperature increased and that less than half the difference in strength was due to the additional water in the warmer concrete. For additional tests made at the different temperatures using a constant water-cement ratio, the 28-day transverse tests showed that concrete placed at 130 deg. F. lost approximately 20 per cent of its strength.

Field Tests—Concrete Curing (Series 1925).—T. E. Stanton, materials and research engineer, California Highway Department.

Tests made at Davis, Yolo County, on California standard 1:2:4 concrete laid in 1925. All sections were covered with burlap immediately after laying and with earth on the following morning. The table shows the results secured at 14, 21, 28 and 90 days, and at 1, 3 and 5 years on pavement cured with water from 0 to 14 days.

		Average Core Strengths, Lb. Per Sq. In.						
		——Days——				——Years——		
Date Poured	Watering Period Days	14	21	28	90	1	3	5
5-27-25	14	3,227	3,789	4,160	4,255	4,393	6,230	6,130
5-28-25	12	3,401	4,021	4,328	4,823	4,531	7,130	6,460
5-29-25	10	3,069	3,616	4,103	4,382	4,631	6,620	6,280
5-30-25	8	3,307	3,404	3,809	4,168	5,089	6,436	6,490
6- 1-25	7	3,025	3,483	4,070	4,812	4,751	6,176	6,480
6- 2-25	3	3,904	4,241	4,045	4,580	4,914	6,770	5,820
6- 3-25	0	3,252	3,349	3,755	3,412	3,511	5,203	4,930

The strength of the section which received no watering remained the lowest at the 5-year test period. The relatively close agreement in strength of the sections wetted from 3 to 14 days shows the importance of effective early curing.

The early strength data on this investigation were reported by C. L. McKesson in the *Transactions* of the Am. Soc. C. E., pp. 137-150, Vol. 91 (1927).

Tests on Transverse and Center Joints in Concrete Pavements.—Reported by Searcy B. Slack, bridge engineer, *Georgia Highways,* Vol. 10, No. 2, February, 1931.

Tests of the effectiveness of different type of joints in transmitting loads from one slab to another were made by applying a heavy load on one side of the joint by means of a jack-type loadmeter and by measuring the deflection of both slabs at the joint or crack by Ames dials. The types of joints tested were: (a) A doweled center joint of the usual V-type; (b) a 2-in. open joint across the pavement without dowels, the edges of the slabs being free to move; (c) an ordinary transverse crack about 1/16 in. wide; (d) a doweled transverse joint, formed by a ½-in. strip of bituminous felt through which were passed ¾-in. smooth bars 4 ft. long, spaced 2 ft. 8 in. center to center, with one end of the bars greased and inserted in an expansion sleeve. The tests were made on Georgia standard pavement 9 in. thick at the edge, 6 in. thick at the center and 20 ft. wide.

The deflections for a load of 10,000 lb. measured to 0.0001 in. show averages as follows:

Where Made	Deflection on Side of Load	Deflection on Side Away from Load	No. of Tests	Remarks
Center joint	57	50	2	Consistent results
½-in. exp. joint	132	17	5	Erratic results
2-in. exp. joint	197	24	5	Fairly consistent results
Trans. crack	155	60	5	Fairly consistent results

The results indicate that the V-type center joint with dowels is very effective in transmitting deflection across the joint. The dowel bars passing through ½ in. of bituminous material were not effective in transmitting

deflection from one side of the joint to the other. Dowel bars make it difficult to spade the concrete adjacent to the expansion joint properly and frequently honeycomb or stone pockets occur below or adjacent to the bars. Based on these observations, a proposed method of reinforcing edges of paving slab adjacent to transverse joints is suggested. Detailed drawings of the various joints are given.

New Mexico's Experience With High-Viscosity Oil.—E. B. Bail, construction engineer, *New Mexico Highway Journal*, February, 1931.

California oil of 340 viscosity (Engler) mixed in place with disc and blade gave a more stable surface than did the 65-70 oils, especially in the presence of moisture. Such material can be economically worked only in fairly hot weather, unless a plant mixing method is employed. The report gives comparative costs and describes the experimental development of the process.

Cement-Bound Roads in Ireland, County Donegal.—John Caffery, county surveyor, *Surveyor and Municipal and County Engineer*, April 10, 1931.

A description of the resurfacing of 7½ miles of cement-bound road. It was constructed in half-widths to convenience traffic, and placed non-continuously in alternate 50-yd. lengths. A layer of 2½-in. stones was spread and rolled with an 8-ton tandem roller. One inch of 1:2½ mortar was placed over the stone base course. A course of 2-in. stone was evenly spread on this mortar and thoroughly consolidated with the roller. When mortar appeared between the crevices of the stones, the surface was slightly "wetted" and swept with coarse brooms. Total thickness of resurfacing was 4 in. Cost per square yard was 81 ct. The road surface presents a mosaic appearance and has cost nothing for surface since it was laid four years ago.

The Resistance of Stone to Frost Action.—W. A. Kessler, civil engineer, U. S. Bureau of Standards. New International Association for the Testing of Materials, pp. 37-44, Group B (1930).

The object of this paper is to show various relations between frost resistance and some of the more easily determined characteristics of limestone. The results were derived from an extended series of tests involving the commercial limestones of the United States. The materials are considered in two groups. One consists of 20 limestones of considerable range in characteristics, while the other comprises 13 limestones of the same type and similar characteristics. Of the properties studied, strength and absorption appear to be of considerably more value in judging frost resistance than saturation co-efficients or wet strength reduction.

Structure of Weather-Resisting Rocks.—A. L. W. E. Van Der Veen, civil engineer, The Hague, Holland. New International Association for the Testing of Materials, pp. 10-12, Group B (1930).

Fossilization (cementation) of a sediment is accomplished by solutions circulating in its interstices. The microscope reveals the mineralogical composition of the sediment, and the nature of its cement. The chemical analysis of a weather-resisting rock may suggest that something is wrong within, whereas the microscope reveals that the dangerous atoms are locked up in most resisting minerals. There follows a description of the relation between genesis and weather-resistance of some sandstones and marbles.

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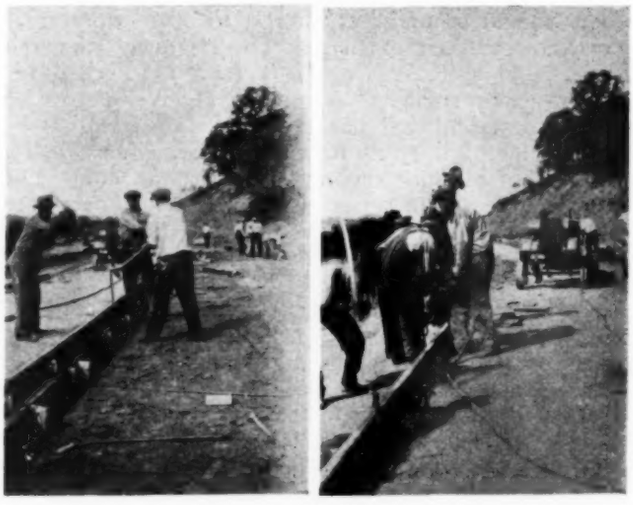
WIDE SHOULDERS.—Shoulders 8 ft. wide are now built on all primary roads in California except in mountainous country where traffic is not heavy and the cost of this width for parking off the pavement is prohibitive.

An Unusual Forming Method

W. A. Wilson & Sons, general contractors, of St. Mary's, W. Va., were resourceful in adopting unusual forming methods on a state highway contract in Cabell County, W. Va. An old 18-ft. brick road was resurfaced with concrete and widened to 20 ft. The job was



Close-Ups on West Virginia Resurfacing. At Left—Drilling Holes in Center of Brick Pavement with Jackhammer

Forms Used "Two High" on West Virginia Resurfacing Project

built by half-width construction methods, in two 10-ft. strips. Because of unevenness of the old brick pavement and also because of many superelevated curves, it was necessary to increase the thickness of the outer edge of the pavement to 14 in.

This was accomplished by doubling the form height through the simple procedure of setting one 7-in. road form on top of another and staking both forms at the same time with the same stake. Standard Blaw-Knox road forms and an Ord finisher were used. Half-width construction methods necessitated that the inside road forms be set in the middle of the old brick road, and jackhammers were used to drill the holes for the form stakes. According to C. P. Ingram, superintendent for W. A. Wilson & Sons, this unusual method of meeting a difficult forming problem worked out to the contractor's perfect satisfaction.

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The great tragedy of science is the slaying of a beautiful theory by an ugly fact.—*Leonard Huxley.*

EDITORIALS

County Consolidation

A STUDY is being made of the county administration in South Carolina with the purpose in view of reducing the number of counties in the state. "Whether 15 actually is the number to which South Carolina's 46 counties could be reduced with most practical benefit and economic effect is for the legislature to decide," comments the *Manufacturers' Record*. The impelling motive behind this program is the public clamor for reduction in taxes.

The legislative committee appointed to make the study has an important function to perform in producing its report. Since county road and bridge work forms the bulk of the county business it is hoped that the committee will work closely with the county engineers and supervisors. A thorough analysis of the South Carolina conditions will bring forth principles which other states may employ in studying local conditions in their own domains.

Trends of this kind clearly point to the fact that counties must adopt planning programs and efficient business methods. Only about one-half of the counties in the country have efficient technical supervision of county bridge and highway expenditures. The U. S. S. R. idea of planning completion of definite construction work within a specified time deserves careful consideration by county authorities. A five-year plan or six-year plan adopted, especially at this period in the business cycle, by counties generally is a recommended procedure. Michigan state highway authorities have grasped the idea and are working definitely toward an objective.

Perhaps consolidation of counties is an economic and social advantage.

At any rate, the South Carolina investigation should be complete, and the legislative committee should be given every assistance by the engineers and supervisors of the state as well as by highway organizations.

On Price Cutting

FAMILIAR tales are again becoming prevalent in the road building industry. All along the line from manufacturer of equipment to the contractor who employs this equipment we hear that price cutting tactics are increasing. We are told by some contractors that the present construction business is entirely on a price contract basis; from manufacturers, their salesmen, and distributors we hear that price cutting is gaining the popularity of a fad. Viewed economically this signifies that profits are being sacrificed. Utter disregard for profit, which is the producer's compensation for initiative and business acumen, is an unhealthy sign of business recovery. Recovery can begin only when business becomes profitable and business cannot become profitable when competitive price cutting tactics are employed.

This, it is freely admitted, is only one of the contributing causes to our present unbalanced condition. A more important basic factor tending to regulate business conditions is that of allowing business to make a profit by reducing fixed charges (interest on borrowed money) in proportion to business. In other words mortgage or bond returns should be regulated to conform with general business conditions. Price cutting enters into this picture in the way that profit is eliminated by that one fell blow thus beclouding the important issues and aggravating the return to normal.

The manufacturers, alone, are not entirely responsible for this situation. Public officials with a keen eye to their own political standing, as well as the wholesome desire to get the most for their expended monies, are pitting one manufacturer against another for the sole purpose of getting price concessions. In the case of the contractor the pendulum of desire on the part of the public official to get the most for expended monies has swung to the price end of the scale of consideration and the elements of skill, integrity, reputation and ability to perform are not given adequate remuneration. The result is that many contractors are forced to build on price rather than on quality. Cutting prices of contract work naturally follows with its contributory aggravation to the manufacturer and distributor. In order to purchase the equipment with which to do the price job the contractor is forced likewise, to beat the profit out of a manufacturer's or distributor's sale. These conditions are extant. Price cutting is an actuality in one form or another.

To the manufacturers, themselves, the question is of utmost importance. No concern, regardless of how great its financial strength can continue to operate and sell its products at a financial loss. It can probably afford to play Santa Claus for a short time but only for a short time. So long as public officials and contractors are able to realize price concessions by pitting one manufacturer and his distributor against another just so long will the evil practice continue. If manufacturers will stand pat, refuse to be stampeded into concessions, refuse to cut prices just for the sake of "getting the business," then and only then will they assist the recovery of general business.

Tomorrow's Business Power or the Economics of "Standards"

AS the present conditions in business have shown, one of the best forms of security for capital invested in industry is scientific research. Discoveries of points of law, principle, and fact in natural phenomena today inevitably lead to their practical application in business tomorrow. How does industry advance if not by the application of invention and research to manufacturing methods? American industrial enterprise has enjoyed an envious evolution. This is plainly evidenced by the groups of technicians and industrialists sent by foreign nations to our shores to study American methods. The slow process of evolution of industry by improvements in mechanical equipment has given way to revolution of manufacturing processes by research. Witness radio and commercial air transport—twentieth century developments. It must be fairly admitted that science and research are a power in American industry today.

While a few discoveries are made in schools and laboratories of purely scientific nature, by far the greater number are made in industrial or commercial testing laboratories. In this work, members of the

American Society for Testing Materials take a front seat. The acquiring of knowledge of materials and the development of standard specifications and methods of testing to determine if a material conforms with those standard specifications are powerful influences which underlie our national economic relationships.

In most cases the manufacturer has analyzed and tested his products to determine the uses to which they may be put. The consumer has also tested them to see if they will serve his purpose. Together through the activities of the A. S. T. M., engineers, scientists, chemists, metallurgists in producer and consumer organizations have developed a "standards" to measure the suitability of materials for specific uses and to serve acceptably as descriptions of materials in a contract between the producer and the consumer.

Viewed from another angle, the work of this organization may be termed the balance wheel of business enterprise—construction, manufacture, and production. The "standards" developed define a commodity to such a close degree that exchange of that commodity for some other may be done with a full knowledge of the practicability and limitations of both. Known qualities of materials may be balanced one against the other before a transaction is consummated, thus eliminating the factor of doubt and leaving the transaction entirely in the realm of a business dealing.

County Roads

RECENT discussions and legislation show a marked change in official attitude toward the importance of the county as a road building and maintenance unit. In years past funds were largely devoted to main arterial highways between important centers of population. More recently however, a definite trend toward returning more of the gas tax and motor vehicle funds to the counties for expenditure on county highway systems will be noted with pleasure. This trend is important in that it is a recognition of the importance of the county in the road building machinery of a commonwealth.

Undoubtedly this recognition has come about in part because of the better equipment of county highway departments for doing this important work. To a much larger degree, however, it is due to the fact that county roads are the most important roads in a community.

While there are many counties with first class engineering administration it is safe to say that over half of them lack proper technical supervision over road and bridge expenditures. Most county officials feel that they are giving their constituents efficient service for their tax dollar. The majority of counties are undoubtedly making every effort toward the development of efficient organizations for road construction and maintenance. On a recent trip through some of the southern states one observer was told that the county officials were endeavoring to keep taxes down by curtailing maintenance expenditures. The officials were sincere in their belief that they were serving their counties to the best advantage in so doing. Such action, however, is questioned by engineers who know the economics of highway engineering. This instance was cited simply to illustrate the point that immediate expediency measures of the elected official are not always to the best interests of the county. Deferring maintenance expenditures on the highway investment is comparable to deferring premiums on a life insurance investment. It may be saving money for the immediate period but the expenditure required later to protect the investment increases faster than in direct proportion to time.

The first beneficiaries of more active county road work will, of course, be the residents of individual counties. But in the larger sense, rural and urban, will benefit in like degree. To all except the long-distance motorist, the most necessary road is the county road.

Progressive Legislation for Highway Administration

FOR at least three years the Bureau of Public Roads, the Highway Research Board, the American Association of State Highway Officials and the American Road Builders' Association, and perhaps a few others, have contended for legislation which would improve methods of administering highways in counties, townships and cities.

For example, one conclusion in a report of the Road Builders' Association at its 1931 Convention reads:

> "Township and highway districts within counties should be eliminated as highway supervising units—these highways should be administered through efficient county highway engineering departments."

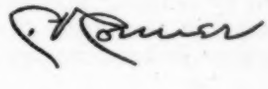
The State of Michigan is convinced that such conclusions are correct as shown by the passage in May, 1931, of the McNitt-Holbeck Bill, known as House Bill No. 333, File No. 172:

> "This measure provides for taking over by the county road commissions of all of the township roads in the state, upon a basis of 20 per cent annually, within a period of five years. It provides that the several counties of the state shall receive from the State Highway Department funds in proportion and according to the methods of distribution set forth:
>
> "$2,000,000 for the calendar year ending December 31, 1932; $2,500,000 for the calendar year ending December 31, 1933; $3,000,000 for the calendar year ending December 31, 1934; $3,500,000 for the calendar year ending December 31, 1935; $4,000,000 for the calendar year ending December 31, 1936, and $4,000,000 for each calendar year thereafter, all such amounts to be paid out of the State Highway Department revenues."

Not content with this progressive step of consolidating secondary roads, Michigan has recognized needed changes in legislation as applied to primary roads and city streets and has made into law House Bill No. 5, File 192, known as the Dykstra Bill.

> "This bill provides for participation by the State Highway Department in the cost of maintenance and improvement of trunk line highways and bridges within municipalities, under the supervision of the State Highway Commissioner, on a graduated scale."

These measures are advanced but not radical as was the recent legislation in North Carolina. They are in harmony with the needs of modern times; and the success of their application to financing and administering highways in the Wolverine state is assured.



County and Township Roads

The Township Highway Problem—I*

What It Is; Steps That Are Being Taken to Solve It; A Proposed Solution, and Recommendations for the Future

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THE increase in the number of motor vehicles registered in the United States from 8,000 in 1900 to 24,000,000 in 1929 has thrown a heavy burden upon the highways of the nation. Much has been written about the national, state and county highways, but it is very difficult to obtain accurate information concerning the administration of township highways. It was thought that a compilation of all available material on this subject would provide a useful basis for a further interpretation and study which would lead to important conclusions. Accordingly, the present research was made, in which a careful study was made of the laws of the various states, of data obtainable through state highway departments and of information contained in the census. While this has precluded any large amount of interpretation and correlation, the writer believes that the report covers practically all information available on the subject.

Better Understanding of Country Roads Needed.—The time has come for a better understanding of the township highway problem. A number of books have been written on the Cumberland Pike and other national roads, but few writers have attempted to describe the "country roads" or advance suggestions for their improvement. This report is written in the hope that the public in general and the highway engineer in particular may have a better understanding of the attempts being made to solve the problem of getting more for the township highway dollar.

Students of political science agree with our road builders that unless more financial aid is assured the townships, they will cease to function as highway administrative units. This failure of the smaller units is general the world over. The smaller units are proving inadequate to provide hard-surfaced ways for the motor vehicle. France, the dean of modern road-building states, with 36,000 communes, has only 3,000 communes with sufficient means to maintain the roads. The percentage in our middle western states, due to a lesser density of population, is much lower. If spent intelligently and economically, there is sufficient labor and capital appropriated to maintain the roads which are yet embodied in any state or county system, but intelligence with economy is a rare combination to be found in the type of man who is available for township road work, and wastefulness is a national characteristic. The farmer has maintained the nation's highways until quite recently. The city-dweller now contributes by the taxes he pays on motor-vehicle operation. The people living on the roadside are doing all that can be expected. If better highways are needed, every one must contribute.

This report is intended to describe the township highway problem, outline what is being done to solve it, submit a proposed solution and make certain recommendations for the future. This investigation, extending over several months, has included highway administration, finance and engineering in the United States, and particularly in the townships, where the situation is becoming critical. A study of the literature on the subject, and a survey of conditions in the field, compel the conclusion that, with the growing demand for better highways, the townships must receive financial aid if they are to construct traveled ways.

In the belief that the township highway organization has outlived its usefulness, and that, since the motor vehicle has come into general use, the county is really no larger than the township of the horse-and-buggy age, the writer would recommend that the administration of the township highways be taken over by the county.

The Primary Civil Divisions.—A concise statement of the primary civil divisions is given in the following quotation from the United States Census of 1920:

> The political units into which the counties are subdivided are collectively termed "minor civil divisions." In most states these divisions comprise two classes, which are termed primary and secondary. The primary divisions are variously known as townships, towns (unincorported), election precincts, beats, etc. In most states the smaller cities and other municipalities form parts of the primary minor civil divisions in which they are located, and are therefore termed secondary divisions; but in Pennsylvania, all incorporated places, regardless of their size, are independent political units, not forming parts of any civil divisions smaller than a county; in New Jersey all incorporated places form primary divisions except three cities, one town and two villages, each of which is coextensive with the township in which located; and in certain other states some of the small municipalities are primary divisions and others are secondary divisions.

The primary civil divisions are nearly 45,000 in number and vary in population from 1 in Wingfield Precinct, Mineral County, Nev., to 23,866 in Lower Merion Township, Montgomery County, Pa. The population

*This paper, which was presented at a recent annual conference on highway engineering, held at the University of Michigan, is an abstract of Mr. O'Connor's fellowship report, which is on file in the Transportation Library of the university. The second portion of the paper will be presented next month.

in most of these divisions is less than 1,000.

Distribution of Primary Civil Divisions.—The distribution of the primary civil divisions is shown in Table I.

The primary civil divisions which are organized for the purpose of administration of highways are the towns in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont, and the townships in Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, North Dakota and Wisconsin. In the other 25 states the county is the smallest unit organized for the purpose of highway administration.

Urban and Rural Population.—The Census Bureau classifies as urban population that residing in cities and other incorporated places having 2,500 inhabitants or more and in towns of that size in Massachusetts, New Hampshire and Rhode Island. It defines as rural, all incorporated places having fewer than 2,500 inhabitants, except in Massachusetts, New Hampshire and Rhode Island, where it consists of all towns under 2,500. That the rural population is increasing at a decreasing rate is shown in the following table:

Class	1920	1910	1900	1890
Urban	54,304,603	42,166,120	30,380,433	22,298,359
Rural	51,406,017	49,806,146	45,614,142	40,649,355
Totals	105,710,620	91,972,266	75,994,575	62,947,714

In spite of the continued drift of rural population to the city, there are actually more people in the rural districts than ever before and their per capita wealth was never greater. In consequence, the amount of money available from property taxes for the maintenance of highways grows steadily. These people are also contributing to the upkeep of the nation's highways through the taxes on motor-vehicle operation. Still it is insufficient, for very little of the money so raised each year finds its way back to the roads over which the farmer must drive to his markets. If, however, the number of persons moving from the rural districts to the city should increase more rapidly than the birth rate, there would be fewer people left on the farms and consequently less interest in local self-government. Taxes will not be affected as they are applied to the property. With fewer taxpayers living in the townships, local interest in the administration of highways will wane and county control will be the final result.

TABLE I—DISTRIBUTION OF PRIMARY CIVIL DIVISIONS

Township	Number of States
Arkansas, California, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, North Carolina, Ohio, South Carolina, Wisconsin	12
Township-Town New Hampshire, Oklahoma	2
Township-Precinct Arizona, Illinois, Nebraska, Washington	4
Township-Borough Pennsylvania	1
Township-Borough-Town New Jersey	1
Township-School District North Dakota	1
Township-Fractional Township-School District-Town-Precinct South Dakota	1
Plantation-Township-Town Maine	1
Town Connecticut, Massachusetts, New York, Rhode Island, Vermont	5
Town-Hundred Delaware	1
Precinct Alabama, Colorado, Florida, Idaho, Oregon, Utah	6
Precinct-Township-Mining District Nevada	1
Precinct-Town New Mexico	1
Precinct-School District-Joint School District Montana	1
Magisterial District Kentucky, Virginia, West Virginia	3
Police Jury Wards Louisiana	1
Justice Precinct-School District Texas	1
Election District Maryland, Wyoming	2
Civil District Tennessee	1
Militia District Georgia	1
Beat Mississippi	1
Total	48

In the Shaded States of This Map the Township Is a Definitely Organized Area of Local Government

Government of Primary Civil Divisions.—A quotation from "The Government of the United States" by W. B. Munro will serve to indicate how the primary civil divisions are governed:

> Local government in the United States, it need hardly be explained, is exclusively a matter of state control. The national government has nothing to do with it. Each state has full power to devise its own system of town, township, district or borough government, and to modify this system at will. But although each state is supreme as respects its own form and functions of local government, the state legislatures are not always given a full hand in such matters. The state constitutions contain many limiting provisions which guarantee to the local units their existence and the possession of various privileges. And as constitutions are revised the tendency is to insert more of these restricting provisions. Nevertheless, the towns, townships, villages and other communities are largely under the legislature's control. Acts of the legislature provide what officers a community shall have, how they shall be chosen and what their duties shall be. Such acts are usually of a general character applying to all local areas of the same legal character—that is, to towns or townships as a class; but special laws applying to individual communities are also common except in states where they are forbidden by constitutional provision.
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> The idea that towns have inherent and inalienable rights because they are in many cases older than the states is widely held by town officers in New England; but it is without any legal basis. The New England town is as completely under the thumb of the state legislature as is the western township or any other area of local government.

Mr. Munro points out that it is very difficult to describe local self-government in the United States. The fact that there is such a diversity in the organization of the minor civil divisions in the various states is a weakness of the system. Of recent years the people

in those divisions have been thinking along the lines of centralization. The county, which is common to all the states, is slowly becoming of more importance in highway administration. As the agent of the state in administering state aid, the county is assuming more complete control over the township highways.

History and Development of the Townships.—The origin of the township is lost in antiquity. The early Romans had road districts which contributed to the maintenance of roads but these districts were not organized—for administrative purposes. Rather, certain stretches of highway were let by contract to individuals who collected toll from travelers on the road and from the adjacent property owners. Tacitus, the Roman historian, relates that there were organized districts in Germany in the first century. Local self-government became more pronounced in England and came to this country with the first colonists, being retained after the Declaration of Independence from political expediency. The township, as we know it, came from New England as the settlers moved westward through New York, New Jersey and Pennsylvania. Unlike the New England town, these townships have artificial boundaries and were created by surveys as described by the late Prof. H. B. Merrick in a series of notes given to his students of surveying at the University of Michigan:

At the close of the Revolutionary War the title of all the land in the newly formed United States was vested in the various states. Gradually definite boundaries were fixed upon for each state, and all the land outside of these boundaries was ceded by the states to the federal government. Other territory was acquired from the Indians and all their claims were adjusted. Still other areas were acquired by purchase until the government found itself with an immense public domain and a considerable deficit in the treasury.

As settlers were constantly seeking new fields and wishing to acquire title to land it was decided to offer the public lands for sale to provide funds for retiring the public debt. In order adequately to describe lands so sold, it became necessary to devise some scheme of survey to insure that the boundaries of the parcels sold should neither conflict nor overlap.

Some such need as this had arisen while the land was still in the possession of the colonies and each colony had worked out a system of its own for conferring title to lands. The land system of Pennsylvania was as well worked out as any. Penn's idea was to lay out the land into townships of about five to ten thousand acres each with the idea of selling in large tracts to wealthy individuals or corporations. The owner was then to subdivide the tract bought in any way he saw fit. The sale was made first and a deputy surveyor was appointed to lay out the boundaries. The purchaser and the deputy went upon the ground and the outlines of the land desired were fairly and visibly marked. The purchaser paid the deputy's fees.

Connecticut insisted on the extension of the township system over the lands ceded by her to the Confederation. The land was to be laid out and surveyed in townships in regular form. This same system was advocated by a committee which reported on the cessions of New York, Virginia and Connecticut and on the petitions of the Indiana, Vandalia, Illinois and Wabash companies. It recommended that the new state be laid out into townships of the quantity of about six miles square.

The systems developed in the north and the south seemed to differ much as the temperament of the people differed in those days. In the north the orderly system of laying off in tracts more or less regular in outline and according to some established system prevailed. In the south irregular and isolated areas were laid out with no respect to relative locations. It is possible also that some influence manifested itself which had its origin in the systems of land survey existing in the countries from which colonists had emigrated.

But the acquisition of the public lands made possible a national system and congress was moved to lay out and regulate the sale of western lands. The actions of the colonies along these lines had much influence on the discussions which preceded the report of a committee which outlined the beginning of the United States Land Survey. Speculation in new land was rampant in those days. Several of the states had opened land offices and expected to increase their incomes and to use the proceeds to retire public debts. Congress therefore took the matter seriously and looked upon the immense areas belonging to the public domain as a very valuable asset to the government which should be carefully managed. Early in 1781, Pelatiah Webster had proposed a scheme which was highly suggestive. He said that the ceded territory should be surveyed into townships of six, eight or ten miles square and sold at auction. His idea was that the townships should be laid out in tiers and sold a tier at a time. In this way the frontier would be more closely settled and in less danger from attack by Indians.

On May 7, 1784, a committee, of which Thomas Jefferson was chairman, reported, recommending the distinctly New England system of surveys. The territory was to be divided into "hundreds," of ten geographical miles square, each mile containing one geographic mile of 6,086.4 ft., and the hundreds divided into lots one geographical mile square, each containing 850.4 acres. The lines were to run due north and south, by the true meridian, and east and west. Although the report was in Jefferson's handwriting there is no evidence that he invented the system. Its merit lies in the fact that it was the best that had been presented for consideration up to that time. In March of the next year the report was again considered, and at that time a more carefully worked out plan was brought forward. The same general scheme was advocated, retaining the rectangular form. But the townships were to be seven miles on a side instead of ten, and the statute mile was substituted for the geographical mile. Surveys previous to sale were recommended because they would give information concerning the land to be sold, and because they would preclude "controversy on account of the bounds to the latest ages." The survey into squares was advocated because it would be the cheapest as in most cases but two sides to the square would need to be run. On May 20 the Land Ordinance of 1785 was finally passed by congress and in its amended form was substantially as follows: The territory ceded by the states was to be disposed of as soon as the Indian title was purchased. The land was to be surveyed into townships of six miles square, subdivided into lots one mile square. The first lines north and south, and east and west, were to commence on the Ohio River at the Pennsylvania border, and only the township lines were to be actually surveyed.

The original intention of the government survey was to divide land into convenient parcels for sale. Any regular subdivision would have served this purpose. But, once divided, the government endeavored to make political units of the townships. The civil township in most cases followed the lines of the congressional township regardless of density of population, topography or the needs of the inhabitants. These new townships were not so highly organized as the New England town which was the natural result of necessity. Kirk H. Porter, in "County and Township Government in the United States," stresses the fact that the organized township has never been really needed:

Efforts were made by the national government in 1785 and 1787 to stimulate a sense of unity and a desire for self-government in these small areas (the surveyed townships) and the state governments followed up these efforts. For the most part the old congressional townships were accepted and the civil townships were made coterminous with them. Machinery of government was created and the inhabitants literally invited and urged to govern themselves through political institutions. The township was destined never to possess very much vitality. Artificial stimuli have kept the machinery in existence, but the township as a unit of self-government is still declining, and even in those states where it does exist it is unable to command the vigorous interest of the people.

Closely to be associated with this situation are two outstanding facts. First, it is the custom for communities to organize as petty municipalities, thus taking the heart out of what otherwise might be thriving townships. Second, the county organization is always adequate and ready to take over all the township functions whenever public opinion is ready to have this done. Thus the township is between two forces, both of which are sapping its vitality. Social and economic forces are also at work to the same end.

The number of organized townships steadily increases. There are over 25,000 of them, more than all the other primary civil divisions. The organized townships are destined to continue as such unless for material reasons their authority is handed over to the counties. Considering the rapidity with which the states

tormed highway departments in order to participate in federal aid, it is highly probable that the townships would be glad to throw in their lot with the counties if state aid were increased, on the condition that the county administer the funds so created.

Present Organiaztion of the Townships.—There are 17 states in which the township is organized for the purpose of highway administration. Of these states, New Jersey, New York and Pennsylvania, due to their location and early settlement, have proceeded further in their road-building programs than the middle western states and each has evolved a distinctive form of organization. The highway laws of New Jersey state that:

> There shall be set aside annually on the first day of October or as soon thereafter as available from the net receipts of the motor vehicle fund the sum of $1,050,000 which shall be used to meet the state's share of the cost of the work hereinafter prescribed. Payments from this fund shall be made in the same way as other payments from the motor vehicle fund.
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> Any township committee may on its own motion apply to the said commissioner for aid under this act. Such application may be passed by resolution of said township committee at any meeting. It shall set forth the road or roads on which it is proposed that the work shall be done and the beginning and ending points of such work, and the amount of money the said committee may be authorized to spend on the work, including any contributions thereto.
>
> The state commissioner of public roads shall decide which applications in any county will best serve the interests of the township, county and state. He shall notify the township committee of his approval of such applications and shall thereupon enter with them into a written agreement for the necessary planning and surveying and for the doing of the actual work and for the inspection thereof. Said work may be performed, in whole or in part, by the labor of prisoners, by contract, either with or without advertisement, but advertisements shall in every case be made upon the demand of said commissioner.
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> The work contemplated includes, in addition to constructing said road, the survey and preparation of plans, profiles and cross-sections, the grading and drainage of the road and the construction of the necessary culverts and bridges whose construction and maintenance are by law now imposed upon the township authorities.
>
> The share of the cost of the work to be assumed by the state shall not exceed 75 per cent of the cost of the actual work.

In New York state, the township is called the "town." The office of town highway commissioner has been abolished and a town superintendent is elected biennially. When needed, a deputy superintendent may be elected. The maximum salary of the superintendent is $2,500 per year. In the more populous counties, the town board of supervisors may appoint the superintendent, whose chief duty is the maintenance of highways. Each year he must present to the town board an estimate of the money required to be raised by tax. Under the supervision of the district or county superintendent, he may award contracts for road work.

The state of Pennsylvania has a central bureau for the supervision of township highway administration, construction and maintenance. The state highway department includes an engineer and staff who apply themselves to the township highway problem. Townships are divided into first and second classes. Those having a population of at least 300 per square mile are designated as first class. All other townships are second class. In townships of the first class, there are five highway commissioners elected every four years. The board of commissioners may appoint one or more supervisors or engineers of highways. The board may enact, ordain, survey, lay out, widen, straighten, vacate and relay all roads, streets, lanes and alleys and parts thereof in the township.

In townships of the second class, there are three township supervisors elected for six years. The supervisors have charge of the roads and divide the township into one or more road districts. They employ a superintendent for the entire township, or a roadmaster for each district. Supervisors may, however, do this work themselves, subject to the rules and regulations of the state highway commissioner. When employed in this way, they receive a maximum of $4 per day. The board of supervisors may contract for the improvement and repair of not over 10 miles of road. They may contract, sell bonds, raise taxes, etc.

Townships may be divided to suit the inhabitants, and new townships may be made from parts of two or more townships.

A public Act of 1923 provides that the motor-vehicle fees dedicated to the state highway department may include the payment of state rewards for the construction and improvement of township roads and the erection and construction of township bridges in townships of the second class. These townships may receive state aid up to 50 per cent of the cost of the work, not to exceed $6,000 per mile.

The form of organization in the townships of the remaining 14 states is fairly uniform. These states are Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota and Wisconsin. The words "town" and "township" have the same meaning, but the organized town or township may comprise one or more congressional townships or parts of two or more congressional townships. The electors assemble annually and elect one or more supervisors, trustees or commissioners and various other officers. As a rule, three of the officers form a board for highway administration purposes. The board may appoint as many supervisors or overseers as there are road districts. The matter of road districts is one of convenience. The organized township may be a road district or may be divided into several districts. Road districts formed for the purpose of routine maintenance should not be confused with the road districts formed for special improvement purposes.

To quote from T. H. Noble, chairman of the Grosse Ile Road Commission, Michigan:

> The township is the smallest of our governmental subdivisions. If properly organized, it will first determine which thoroughfares are likely to be taken in hand by its county and state. It is not claimed that organization is a panacea for all the ills affecting the efficiency of township work. The mere fact that township work is being conducted under state specifications, and subject to the inspection of its trained engineers, inspires confidence, stimulates pride and improves the morale of all that portion of the community capable of being affected by such influence, and thereby the efficiency of the working force is improved. The only way to establish standards of excellence, and perpetuate a policy, is to fall in line, and as a ward of the state, and by a faithful observance of its requirements, enjoy the benefits of its patriarchal attitude. A proper organization and education in road matters necessarily go hand in hand. The organization will demand the education of its officers, and education will demand organization. We believe that the shortest route to an improved condition is by inducing a more general attendance at the road schools.

The doctrine of education and cooperation will help the officials who handle highway funds to spend them wisely, but the funds are inadequate. Our leading students of political science agree that too much money is expended on overhead and unnecessary duplication of road organizations. The political scientist favors centralization. The county, as a unit common to all the states, is recommended to be the smallest political unit.

Kirk H. Porter[1] describes the weaknesses of the smaller divisions in these words:

> The outstanding characteristic of the county and township is that they are, and always have been, areas for local self-government. The measure of real discretion resting with the county or township comes to be less and less each year, and the functions which local authorities have to perform simply as agents of their own community are less and less important. This is a result of the extension of state activity and control, as well as a declining interest in local governmental institutions. American democracy has its roots deep down in the county and the township, and the county particularly is the very basis of the political structure in most of the states. The county particularly tends to assume the character of a pure administrative district for the purpose of carrying out a state program. On the whole, the township has ceased to be a necessary institution of government. It serves no important purpose that cannot be more conveniently and effectively served through other agencies. The mere fact that no townships are to be found in more than half the states is eloquent proof of this. Poor relief, highways, drainage and education are all matters that could be handled to better advantage through county machinery. It has been the practice in these states, which include most of those in the south and west, to divide the counties into special districts through which may be exercised the functions that elsewhere are performed through instrumentalities of the township. These districts differ very distinctly from townships, however, in that they ordinarily do not possess any of the governmental machinery and powers that go with real local self-government. That is, they do not have political machinery through which policies can be determined, tax rates imposed, appropriations made and governmental activities carried on more or less independently of other areas of government. Power to do such things is the essence of local self-government, and ordinarily is possessed, to a certain extent at least, by townships. County districts do not have these prerogatives, and in the few cases where townships do not have them, the township is in effect nothing but a county district, masquerading as a township.

That organized townships do not exist in more than half the states is not conclusive proof that they are not useful. They do exist in the older and more densely populated states, and are functioning in more than half of the area of the United States which contains nearly three-fourths of the population. That the township organization is not in use in California, one of our most progressive and wealthy states, is evidence that the township organization is not essential. It would be difficult to prove that the organized township is a detriment, but there seems to be no doubt that a considerable economy could be effected were the township organization for administrative purposes to be discontinued.

The Township Highway Problem.—In the present study, consideration of the township highway problem is limited to the 17 states in which the township is organized for administration purposes. In the 17 states, there are 25,087 of the 45,000 primary civil divisions in this country. They cover an area of nearly 1,000,000 square miles, or 32.7 per cent of the area of continental United States. The population by the 1920 census was over 66,000,000, or 62.4 per cent of the total population of continental United States.

The highways in the townships of the divisions studied were intended in the U. S. Land Survey to be located between sections, or 1 mile apart. This has been followed, but there are exceptions where the topography does not permit regular spacing or straight lines. Some of the township highways are given roads; i. e., the owners dedicated the land for highway purposes for their own convenience or when suitable locations were not available at section or township lines. These highways vary in width and have frequent changes in alignment. The usual township highway, however, is 1 chain wide (66 ft.), straight between township lines (6 miles) and has given good service until motor vehicles became so numerous. These vehicles require a smooth, firm surface if they are to operate efficiently.

The townships, unless they become populous and wealthy, will never be financially able to maintain all-weather surfaces wide enough for two lanes of moving motor vehicles, but this is precisely what the motoring public wants. In meeting this problem, then, the townships must receive financial aid to render this service.

The township highway problem is due largely to the fact that the organized townships cannot maintain their highways under present conditions of traffic; i. e., slow-moving heavy motor trucks which rut the surface, and rapidly-moving light motor vehicles which suck the lighter particles from the surface and expose them to the wind, which scatters them. The mileage of highways is fairly constant; the money available from property taxes cannot, without hardship, be increased.

The critical period, the time during which the frost is leaving the roads, varies in date and duration. The traffic steadily increases. Traffic requirements are increasing more rapidly than property taxes. The dollar spent on maintenance, due to the varying weather conditions each spring, does not give the same returns from year to year. The only factor in this problem which admits of any control is the money to be spent on construction and maintenance.

The state of Michigan has under consideration the diversion of more of the money raised from the gasoline tax to the townships, the fund so created to be administered by the county.

The Typical Township.—The typical township has a population of less than 1,000, has 25 to 125 miles of highways and about $5,000 per year to spend on roads and bridges. The situation is changing in respect to the farms. A few years ago, there would be from four to six farms per square mile, with four to six dwellings housing 20 to 30 people. Mechanical and power-driven equipment has improved rapidly, and its increasing use decreases the number of persons required to work the land. In consequence, farms tend to become larger and the number of persons following agricultural pursuits smaller. The mileage of highways and the local road funds remain fairly constant. As the number of people engaged in farming decreases, interest in local institutions will wane. This is increasingly true because the poor farmer who has time to dabble in politics or work on roads is being eliminated. The good farmer is too busy to enter political life, and can spend his time more profitably than in road work. A count in Michigan shows that over a period of ten years 58 per cent of the highway commissioners were replaced annually. In one township there were 48 pathmasters who each had about $100 of road funds to administer. The results obtained could not be satisfactory.

Township roads are generally supplementary to the county system, and some of the more wealthy townships are delegating their maintenance and improvement to the county, as a measure of economy in securing the service they desire. These roads extend to every owner's land, and are improved as the pressure of public opinion may be exerted and funds become available. Primarily they are market roads, and radiate to villages or main roads. In some instances, the financial interests of the cities or villages contribute to the local funds and help build radiating roads into fertile business districts. This type of construction was typical of early development, and accounts for the fact that an area may consider itself tributary to one town more remote than another. In many cases, through traffic was discouraged by almost impassable roads between ends of

[1] "County and Township Government in the United States."

these radiating highways. This is simply a type of failure in service, resulting from the lack of a broad view and appreciation of the problem.

John A. Fairlie, in his book "Local Government in Counties, Towns and Villages," has a concise statement of conditions in the minor civil divisions:

> Roads in the county districts have been for the most part constructed and repaired by a labor tax, worked out under the supervision of highway overseers, often elected by road districts into which the townships are divided. In the public-land states, the roads for the most part run along section lines, with but slight avoidance of grades or attention to the shortest lines of traffic. Within recent years, however, the use of money taxes and technical experts in road building has been extended. At the same time, the tendency has been to substitute the town for the minor district as the primary administrative unit. Progress has also been made in the building of county roads; in some states the movement for better roads has been promoted by state aid and state supervision.
>
> Little is known of the character of township government in general; the absence of complaint seems to indicate that, on the whole, it satisfies the people of the various communities. But it may be noted that the decline of the town meeting leaves no active control over the officers; and it is likely that in sparsely settled districts there is a good deal of carelessness in the management of local affairs.
>
> A correspondent from northern Minnesota writes that many irregularities occur in connection with the management of township matters in that state. A supervision over township accounts similar to that exercised over county accounts in some states might disclose a good deal and pave the way for improved methods.

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Activities of County Highway Officials' Division of A.R.B.A.

CONTINUANCE of cooperative studies of highway problems by county officials has been heartily endorsed by county engineers and supervisors of the several states. This cooperative work finds expression in the County Highway Officials' Division of the American Road Builders' Association. The activities of this division, the past year as in other years, have been directed toward developing and improving county highway standards. Many problems of a non-technical nature discussed and analyzed by county officials and cooperative activities with other associations demonstrate the growing interest in secondary or county highway development and indicates the possibilities of the influence for county road programs that can be exerted by an organized body of county officials.

Committee Activities.—During the past year committee studies of the County Highway Officials Division were devoted particularly to problems of financing, administration, planning, construction and maintenance methods, and public relations. Five committees as listed in the 1930 activity folder conducted investigations and prepared reports relating to important phases of these timely subjects for the 1931 convention. The high quality of the reports and papers established for the division in the past was maintained. New developments and ideas were noted. Definite principles were defined on several subjects and examples presented to demonstrate their practical application.

The Public Relations Committee, a new committee formed during this year, presented a program which was especially well received and indications are that this committee will be an important factor in carrying forward the program of the division for favorable public opinion for secondary highway improvement by counties.

County representatives were active on committees preparing a number of the general association reports, including the reports on Finance, Snow Removal, Methods for Purchasing Equipment, Needs for and Availability of Maintenance Equipment, Traffic Devices and their Application, and Grade Crossings.

The standards, which the reports propose, aim to eliminate wasteful practices and promote improved results, greater efficiency, and economy in all county highway operations.

Affiliation Plan for State Associations of County Officials.—Special effort was directed to bring about close cooperation between the County Highway Officials Division and state associations of county officials. During the year nine groups, listed below, were added to the mailing list which now contains thirty-eight state associations representative of county officials in thirty-five different states: Association of County Commissioners of Alabama, County Supervisors' Association of the State of California, County Highway Officials' Association of Delaware, Association of County Commissioners of Georgia, Indiana Association of County Surveyors and Engineers, Police Jury Association of Louisiana, Eastern Shore Association of County Commissioners (Maryland), Association of Chosen Freeholders of New Jersey, and County Highway Officials' Association of Virginia.

The plan for affiliation of state associations approved in March, 1931, establishes a means whereby more intimate contact is possible with the officials of the state associations. Its adoption by the executive committee of the American Road Builders' Association marks a definite advance for the county division.

Proposed Activities.—At the recent annual meeting of the division suggestions for 1931 activities were discussed and the following prepared as a general guide:

1. Administration and Finance.
   - (a) Uniform Accounting (according to county classification).
   - (b) Purchasing Equipment Practices.
   - (c) General Requirements-Specification Forms.
     - Prequalification of Bidders.
     - Advertisements.
     - Invitation to Bidders.
     - Bidder's Bond.
     - General Information.
     - Contract.
     - Performance Bond.
   - (d) Methods of State Aid Extension.
2. Regional Planning.
   - (a) County Manual Outlining Planning Procedure.
   - (b) Standard Legislation Enabling Acts.
   - (c) Aerial Photographs.

3 and 4. Design—Construction—Maintenance.
   - (a) Widening and Reconstructing (continued).
   - (b) Surface Treatment Specification.
     1. Materials—
        - Mineral or non-Bituminous.
        - Bituminous.
     2. Construction Methods.

5. Public Relations.
   Methods of Promoting Bond Issues.

Policies.—All of the various activities of the division are related to one or more of the nine points or special aims of the division:

1. Favorable legislation.
2. Comprehensive plans coordinated with state plans.

3. Increased county programs.
4. Better business methods.
5. Competent supervision.
6. Standard construction.
7. Regular and systematic maintenance.
8. Complete publicity of county operations.
9. Active cooperation with other official and unofficial agencies and associations, promoting better roads.

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Caution Legislators To Recognize Counties

On the same day, April 16, 1931, that the East Texas County Judges and Commissioners' Association were meeting in Palestine, the West Texas County Judges and Commissioners' Association were in session at Abilene. The latter group soundly scored certain legislators for their failure to recognize county officials and county government. The organization adopted a resolution calling the attention of legislators to the fact that they owe it to themselves, as well as to the public to consult with county officials when considering matters pertaining to county government. In Texas the Commissioners' Courts correspond to the Board of Supervisors of some states, the County Commissioners in others, etc. It happens that the Texas law includes the County Judge as a member of this county governing body.

In the North Carolina case, for example, the counties were not consulted with the result that jurisdiction over all road work was taken out of their hands and concentrated in the hands of the state. It is at this undemocratic procedure that the Texas Association is striking. In their resolution they declare that their territory is entitled to just recognition in the passage of laws by the legislature, especially in regard to county affairs and county financing; that on many such legislative matters the Commissioners' Courts are better informed and know more about the needs of their counties than do the legislators; that legislators are so crowded with their problems that they cannot seek counsel and advice from the county governments, or else do not care for same, and consequently many laws which are needed to assist and remedy county affairs are ignored while other misfits are enacted; that legislators often do request opinions from a few county officials and thereby get contradictory opinions, and opinions from only a few; and that Commissioners' Courts of West Texas usually find the same common problems confronting them and on purely county legislation said courts have the same general opinions. Like Texas, other states have associations of county engineers and commissioners or supervisors to which legistors could turn for guidance and opinion on county matters. Legislators would do well to work with these associations.

As stated before, on the same day that the West Texas association was in conference the East Texas association were gathered at another place. Their orders of business covered the same matters, practically.

Conforming to the theory that the user of a service should pay for that service, the East Texas County Judges and Commissioners' Association in convention at Palestine, reaffirmed the following resolution which was passed at a former meeting:

"Be it resolved, by the East Texas County Judges and Commissioners' Association, assembled at Lufkin, Texas, this the 12th day of February, A. D. 1931, hereby going on record as asking the Forty-Second Legislature of the State of Texas, now in regular session at Austin, to submit to the voters of Texas a constitutional amendment providing for an adequate statewide bond issue for the purpose of financing a connected system of state highways and refunding to counties a fair and equitable sum for moneys advanced by such counties on state highways, such bond issue to be financed by a tax on gasoline or other motor fuel, and not to be a tax on the physical property of the people of the State."

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Oiling Improves Earth Roads

Experience of the Missouri State Highway Department in the treatment of earth roads with oil since 1928 affords a valuable guide to other states and communities interested in the improvement at low cost of secondary and local roads of light traffic, according to the Bureau of Public Roads, U. S. Department of Agriculture. The results of the Missouri experiments are reported by the bureau in the May Issue of *Public Roads*.

The experiments show that the character of oil used and the object of the treatment differ according to the nature of the soil. Soils which are naturally firm when dry, such as clay, require only waterproofing and may be satisfactorily treated with relatively light oil. Noncohesive soils, such as sand and some kinds of silt, need application of heavier oil which, by binding their particles together, increase their ability to support the traffic loads.

It was found that oil treatments are effective in stopping wash and erosion on roads built of the non-cohesive types of soil. In certain areas, the state highway department was rapidly approaching the necessity of purchasing additional right-of-way, says the report, to obtain additional earth for replacement of shoulders removed by erosion. Oil treatment immediately and effectively stopped the erosion, and made possible large savings in maintenance costs. To prevent erosion, the report says, the oil must be applied to the full width of the roadway.

The condition of the earth road surface immediately prior to application of the oil is of the utmost importance. Surfaces to which oil is to be applied, according to the report, should be fairly free from dust and should have their pores open to receive the oil. To insure these conditions the surface should be slightly moist. Dry surfaces are likely to be both dusty and resistant to the penetration of the oil.

Ordinary vehicular traffic is said to be beneficial to oil-treated surfaces as such traffic tends to knead the oil into intimate contact with the soil particles, a condition which is necessary for success of the oil treatment. Tractors and traction engines with cleated wheels and other vehicles, classed as mutilative, were found by the observers to seriously impair the service of the treated roads, and it is recommended that the operation of such vehicles should be restricted.

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HOUSTON COUNTY BUILDS ROADS.—Plans are under way to begin the $1,450,000 road program of Houston County, Tex., bonds for which were voted about a year ago. The work has been delayed somewhat awaiting a more favorable bond market. Provision has been made for the construction of approximately 65 miles of concrete highways, 68 miles of other hard-surface road and 18 miles of first-class graveling. Important in the appropriation is an allotment of $232,500 to be spent exclusively on lateral roads.

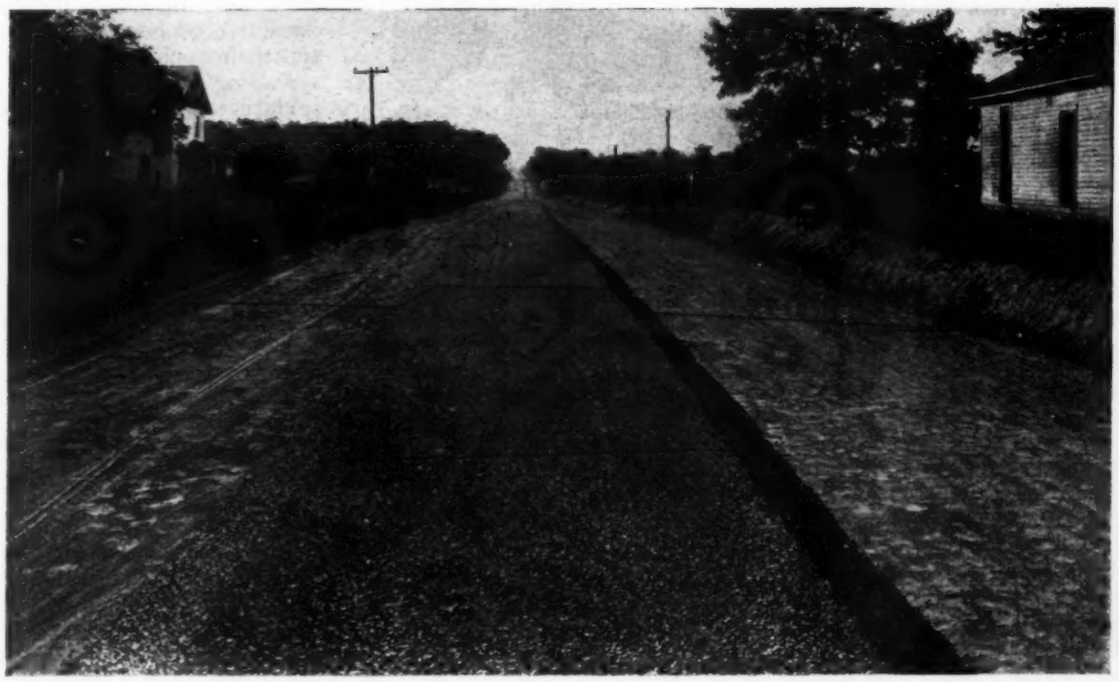
BEFORE

Year-around travel could be assured to farmers living along this Illinois county school road—

It was decided to put a finished grading job on the road—

So that—

Gravel deposited down the center of the finished grade—



Could be spread across the surface leaving a windrow on each shoulder

AFTER Completion

The Road Builders' News

1932 Road Show to Be In Detroit

The 29th annual Convention and road show of the American Road Builders' Association will be held in Detroit, Mich., Jan. 9 to 15, 1932.

The decision as to the location of the road show was made by association officers after consideration of the advantages of several large cities that made strong efforts to get the road show.

The Detroit Airport building will be used for both the convention and the road show. All exhibit space is on the ground floor and the huge doors make possible the setting of the largest equipment without difficulty.

A new plan of housing delegates will be followed this year. An effort will be made to house all road builders, whose interests are alike, in the same hotel, city people in one hotel, county in another, Pan-American in still another and so on through the list. This plan will facilitate locating people at their hotels.

Headquarters hotels will be the Statler and the Book-Cadillac. Division headquarters will be maintained at these hotels. Hotel accommodations for delegates will be better than ever before.

All convention meetings will be held on the second floor of the Airport building where commodious and quiet rooms are available. Four convention rooms will be in use continuously throughout the convention to

care for the many division meetings.

At the Detroit shows all classes and types of equipment and material for the construction, maintainence and operation of streets and highways will be on display.

The event in past years has brought together as many as 25,000 road builders representing all classes of activities. It is expected this number will be exceeded at the Detroit convention.

Joint Committee with State Officials Outlines Work

Under a cooperative agreement for research in equipment problems between the American Road Builders' Association and the American Association of State Highway Officials a joint committee outlines activities. This committee met in Chicago on June 7.

The following projects were approved by the committee: Standardization of shoes or rollers for truck and tractor snow plows; standardization of blades for truck scrapers; standardization of rental rates for state-owned equipment and determination of the relationship to rental rates recommended for privately-owned equipment; traffic devices and their application; equipment for spreading and finishing pavement surfaces; bins and batchers; equipment for handling and weighing bulk cement; equipment for construction and maintenance of low cost road surfaces.

Each of these projects is organized under the control of a committee composed of a state highway official representing the American Association of State Highway Officials as chairman and a staff engineer of the American Road Builders' Association as secretary. Two other committee members are appointed from each association. The various committees will study the subjects assigned and report at the conventions of the two associations.

Present at the joint committee meeting were Fred White, State Highway Engineer of Iowa, chairman; T. H. McDonald, Chief, U. S. Bureau of Public Roads; C. M. Upham, Engineer-Director, and C. N. Conner, Engineer-Executive, American Road Builders' Association. The other members of the committee are F. T. Sheets, Chief Highway Engineer of Illinois, and G. C. Dillman, State Highway Commissioner of Michigan, and the executive committee of the American Road Builders' Association.

Gov. W. M. Brucker of Michigan, Fred Wardell of Detroit, and C. M. Upham, Engineer-Director, American Road Builders' Association, Meet to Discuss Plans for the 1932 Road Show and Convention

Cooperation of Associations on Committee Reports

A dinner meeting of officers of eight associations interested in road building was called by the American Road Builders' Association in Washington on June 1 to consider cooperation in the preparation of reports. The purpose was to eliminate any duplication of effort.

The meeting was attended by the following: Stephen James, Highway Education Board; R. W. Crum, Highway Research Board; G. F. Schlesinger, National Paving Brick Manufacturers' Association; R. D. Bradbury, Wire Reinforcement Institute; A. T. Goldbeck, National Sand and Gravel Association; Stanton Walker, National Ready Mixed Concrete Association; Harry Kirk, Associated General Contractors; E. F. Kelly, U. S. Bureau of Public Roads; and C. M. Upham, C. N. Conner, P. F. Seward, C. E. Grubb and D. R. Lamson, American Road

Builders' Association. The Portland Cement Association represented by Arthur Toner concurred in a later conference.

Discussion in the meeting developed the fact that no serious duplication of effort of the various association activities existed and that plans presented for committee activities of the American Road Builders' Association for the coming year did not overlap the work of any other association.

Cooperative work of the American Road Builders' Association now includes joint efforts with the American Association of State Highway Officials, Portland Cement Association, National Paving Brick Manufacturers' Association, The Asphalt Institute, the tar industry, the Wire Reinforcement Institute, Associated General Contractors, U. S. Bureau of Public Roads, Highway Research Board, American Farm Bureau Federation, National Rural Letter Carriers' Association, County Highway Planning Association and the American Automobile Association.

It was agreed at the meeting that the American Road Builders' Association was performing a most important work in taking up the lag between the establishment of facts through research and their utilization.

Manufacturers Aid in Road Builders' Research

Representatives of manufacturers will assemble on July 13 and 14 at the offices of the American Road Builders' Association in Washington to render aid in the committee work of the association.

Following is the program:

Monday, July 13

Committee on Standardization of Shoes for Truck and Tractor Snow Plows.

Committee on Standardization of Blades for Truck Scrapers.

Committee on Traffic Devices and Their Application.

Committee on Equipment for Spreading and Finishing Pavement Surfaces.

Joint Meeting

Committee on Compaction of Fills as Effected by Type and Size of Haulage and Other Equipment; and

Committee on Rock Excavation, Earth Excavation, Classification of Excavation.

Tuesday, July 14

Committee on Bins, Batchers and Equipment for Handling and Weighing of Bulk Cement.

Committee on Equipment for Construction of Low Cost Road Surfaces.

Committee on Central and Truck Mixed Concrete.

Committee on Highway Location.

Subcommittee on New Developments of Surveying Instruments and Aerial Topography.

Committee on Standardization of Rental Rates for State-Owned Equipment and the Establishment of the Relationship between these Rentals and Those Recommended for Privately-Owned Equipment.

The meetings last year for a similar purpose were productive of excellent results.

Connecting State Routes Through Cities

Many of the state roads stop at the city limits of municipalities of more than 2,500 population and the traveler finds that he has more difficulty in getting over the roads in the municipalities than in the country. Congestion on the roads is usually found in the cities or near them.

To meet this condition some of the states have undertaken to improve the connecting links on state routes through municipalities feeling that such work is essential to a complete highway system that will permit one to travel at will to any part of the state on good roads.

In some cases grants of money have been made to the municipalities for the purpose of improving connecting links and for their maintenance. This practice has done much to improve the general condition of the state systems and has met with the approval of the municipalities where a large part of the motor vehicles are registered. The advantage of this procedure to the farmers is that the municipalities are the best markets for much of the produce of the farms and the prosperity of the cities is necessary to provide good markets for farm produce. To the cities there is an advantage because the most usual method of improving city streets is by the assessment of private property and these assessments make taxes high and to that extent reduce the purchasing power of city folks.

Since taxation of motor vehicles through the license and gasoline taxes have become so widespread almost a billion dollars annually is raised for road purposes, a large part of which is paid by city-owned motor vehicles. These city-owned motor vehicles are used both in the country and in town for the major part of the country traffic is city-owned vehicles. However, there is a large use of motor vehicles that are seldom out of the various municipalities. It has been found that 57 per cent of the automobiles are in towns of under 10,000 population while only about 20 per cent of the motor vehicles are on farms. It is only in the larger cities that the motor vehicles do not go out of the municipalities on the country roads.

The American Road Builders' Association has made many studies of financing of highway and this information is available in their *Proceedings.*

A.R.B.A. Cooperation Planned with Highway Research Board

The plan of cooperation under which joint research work is being carried out by the American Road Builders' Association with the Highway Research Board provides for effective action and the approval of reports by leaders in highway activities.

The fact finding investigations will be conducted by the staff of the American Road Builders' Association under the guidance of the project committee of the Highway Research Board.

Reports of research findings will be presented at the annual meeting of the Highway Research Board and reports dealing with the utilization of the findings will be presented at the annual convention of the American Road Builders' Association.

Projects are selected, and the project statement and research outline approved by appropriate joint committees. The Highway Research Board project committee will supervise the research work, analyze the data, review and approve the report of the special investigator for each project. The American Road Builders' Association will appoint representatives on this project committee. The actual investigative work will be done by staff engineers and special investigators of the American Road Builders' Association.

Utilization of the findings will be determined by a committee of the American Road Builders' Association on which representatives will be appointed from the Highway Research Board.

The first project to be undertaken is a study of the compaction of earth fills as accomplished by type and size of equipment. The special investigator will be appointed shortly.

Safety Found On New Roads

"New roads are designed to fit modern traffic and located so that they are free from sharp curves and wide enough to make the passing of vehicles easy," asserted R. Getty Browning, chairman of the road location committee of the American Road Builders' Association and locating engineer for the North Carolina highway commission. The public should not judge all roads by the same standard; some roads are not modern. In planning modern roads, the character and volume of anticipated traffic must be determined by traffic surveys and prediction of the future importance of the highway.

"Many old roads were built to meet the requirements of horse and wagon traffic. They are often crooked, narrow and dangerous for motor traffic," Mr. Browning declared. "The relocation of many of these roads is a safety measure as well as economy in many cases. It is often possible to shorten a road so much that there is a marked saving in money. Also, the saving to traffic in gasoline and time is pronounced."

The committee stresses the importance of careful study by competent engineers of all highway locations: (1) to promote safety; (2) to find the most economical route; (3) to secure permanence of future improvements such as widening, beautification and real estate developments; (4) to coordinate the highways of the various political units; and (5) to satisfy the public that highway funds are spent only on locations consistent with future traffic needs.

Major requirements that the committee believes should be considered include the cost of the right of way, roadbed and structures, savings in maintenance, service to through traffic, connections to cities, elimination of railroad crossings, and the use of the existing road.

"Highways in country and city in the western states where much new location is possible have an advantage because in the older settled sections well-established conditions debar road authorities from many new and safer locations," explained Mr. Browning. "This does not prevent the improvement of the old road by increasing the visibility and widening for safety and comfort in driving.

"Roads might well be classified according to the traffic," he continued, "class A, 1,000 to 5,000 vehicles a day; class B, 500 to 1,000; and class C, less than 500. Bridges should have a clear roadway of not less than 24 ft. The degree of improvement should be regulated by the traffic as classified."

Stage Construction in Suburban Street Development

The improvement of real estate developments is nearly always preceded by street construction to make the lots accessible to people building houses. The sum of all this suburban road development adds materially to the total mileage of roads and streets improved.

Suburban streets are built of as inexpensive materials as possible in order to keep the costs low for the property owners or for the developers of the subdivision. In some cases, however, brick, concrete, asphalt and other high type pavements have been built and these pavements have a long life.

Reports prepared by the American Road Builders' Association in studies of unimproved streets made by the City Officials' Division of that association indicate that perhaps the greatest economy that can be adopted is that of stage or progressive construction of the streets in suburban developments. By stage construction is meant the building of surfaces for the traffic as needed by the traffic but building each new pavement on top of the old used as a base.

In order that stage construction may be followed, it is evident that all the streets must be carefully surveyed and the grades established for the pavements, gutters, curbs and sidewalks. The next step is to grade the street properly so that the earth at the center of the roadway will be lower by the thickness of the different pavements than the final established grade.

The first stage might be a gravel road which later is given a tar or asphalt treatment. This is followed by a stronger pavement of materials such as brick, concrete, asphalt or similar high type materials built on top of the treated gravel which is used as a base.

Stage construction gauges the type of pavement according to the traffic. Just when to change from one type of pavement is determined by the volume of traffic and the local conditions such as how many of the public utilities have been installed. By using progressive construction on a properly graded street much money is saved in construction and better pavements assured.

City Traffic Details Studied by A. R. B. A.

Seven subjects for study have selected by the traffic committee of the City Officials' Division of the American Road Builders' Association with the purpose of developing definite recommendations for traffic control.

These subjects are: (1) Interpretation of the general concept of right of way; (2) rerouting of traffic with special reference to buses; (3) reducing accidents and congestion by proper design; (4) laning of traffic; (5) radii of curbs at intersections; (6) recommended designs of safety zones including paving and lighting; (7) traffic control at circles and multiple intersections.

Specific subjects will be studied this year instead of a general survey of the traffic problem. This method of treatment should be of great interest to city officials because of its practical applications.

Traffic in cities is a pressing problem at the present time due to the growth of cities in number, area and population and the tremendous increase in the use of streets by motor vehicles. Small cities have their traffic problems as well as large ones.

The development of the City Officials' Division of the association and the display of street construction and maintenance equipment, traffic control devices and materials for street building at the Road Show will be features of added interest during the annual convention in Detroit next year. The Road Show furnishes an excellent opportunity to inspect and study the utility of all kinds of equipment and materials for city street work.

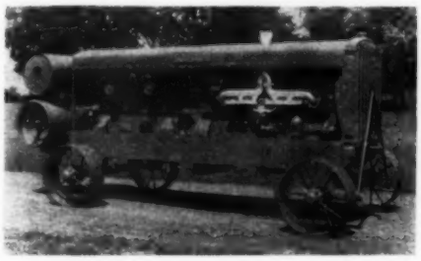
Following are the members of the traffic committee: M. O. Eldridge, Assistant Director of Traffic, Washington, D. C., chairman; J. W. A. Bollong, Traffic Engineer, Seattle, Wash.; W. S. Canning, Philadelphia, Pa.; H. C. Dickinson, U. S. Bureau of Standards, Washington, D. C.; Chas. G. Gonter, Traffic Engineer, St. Louis, Mo.; Maxwell Halsey, Traffic Engineer, Bureau of Casualty and Surety Underwriters, New York City; E. B. Lefferts, Engineer, Public Service Department, Automobile Club of Southern California, Los Angeles, Calif.; Burton Marsh, Traffic Engineer, Philadelphia, Pa.; G. A. Schuldt, Residing Magistrate, Police Court, Washington, D. C.; Hawley Simpson, American Electric Railway Association, New York City; Russell Wise, Chairman, New Jersey Traffic Commission, Trenton, N. J.

New Equipment and Materials

A 540 Cu. Ft. Portable Air Compressor

Schramm, Inc., West Chester, Pa., have developed a multi-cylinder portable air compressor, having 540 cu. ft. displacement. This unit consists of an 8x6-in. 4-cylinder compressor driven by either gasoline or Diesel heavy duty Buda engine.

The underlying principles in the construction of this large compressor are the same as those built in the other Schramm machines. One of the interesting features of this large compressor is the



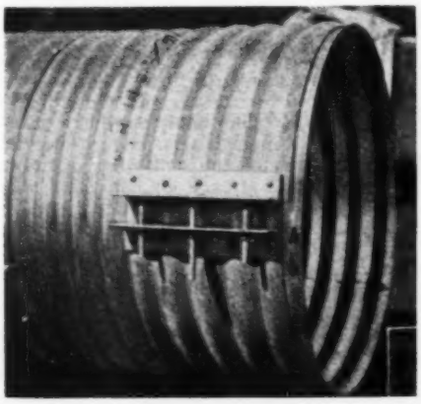
Schramm 540 Cu. Ft. Portable Air Compressor

Schramm self-aligning clutch. This clutch permits the operator to disengage the compressor unit while the engine is being started. After hand starting is accomplished and the engine running smoothly, the full compressor load can be thrown on by a simple pull of the clutch handle. This distinctive Schramm clutch feature makes the starting of these large size multi-cylinder compressors a simple and easy problem.

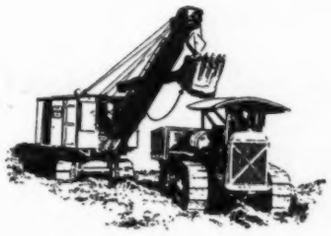
Any mounting, spring trailer, Highway Trailer, steel wheels, rubber tired wheels, can be obtained, which greatly increases the adaptability on any construction job. It is also built for the various stationary installations in factories and shops.

Connecting Band for Corrugated Pipe

A band for connecting sections of Armco corrugated pipe is a recent development of the Armco Culvert Manufacturers Association, Middletown, O.



12 In. Band Placed on Pipe Ready for Shipment



The band is stated to assure strength at the joints equal to that of any of the sections. It is easy to install. The band greatly facilitates the work of lengthening or extending existing culverts. The bands are made in two types: 7 in. width for small and medium size pipe and 12 in. width for moderate and large size pipe.

Smith Truck Mixer Announced by N. E. C.

The National Equipment Corporation, Milwaukee, Wis., with a background of over 30 years' experience in designing mixers for every type of concrete work, announces the Smith truck mixer and agitator.

This unit, incorporating many points

Smith Truck Mixer

of unique design, has the following important features:

A thorough 5-step mixing action, accomplished by clockwise rotating and without reversing direction.

Distinctive egg-shaped drum with the 12-sided panel design.

Full control of discharge—fast, slow or intermittent. Positive discharge—no hoisting or tilting of the drum.

Adaptable to any make of truck of sufficient capacity.

Separate power unit providing longer life of truck and better control.

Roller and ball bearing drum support.

Simplicity and ruggedness of design—saving of weight and unnecessary mechanism.

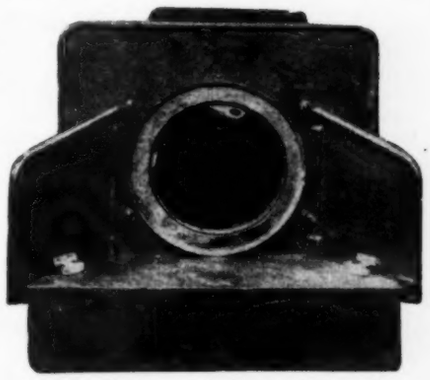
This machine is offered in two sizes. The 1-1½ cu. yd. has a capacity of 1 cu. yd. of resultant concrete as a mixer and 1½ cu. yd. as an agitator. The 2-3 cu. yd. mixer has a capacity in resultant concrete of 2½ cu. yd. and 3 cu. yd. as an agitator. A third size, with a capacity up to 4½ cu. yd. of concrete, will also soon be available.

An illustrated bulletin and complete information can be had on request either from the National Equipment Corporation at Milwaukee or any of its sales representatives.

Cast Iron Headwalls for Culverts

For use with Spi-Cor spiral corrugated cast iron culvert pipe, the American Casting Co., Birmingham, Ala., has designed a cast iron headwall, consisting of a lock ring, a back wall, and side and bottom aprons. The inside of the bell of the lock ring is fitted with thread which snugly engages the culvert pipe.

The side aprons are held in position by locking wings which engage openings in the back wall. The bottom apron is supported and held in position by lugs on



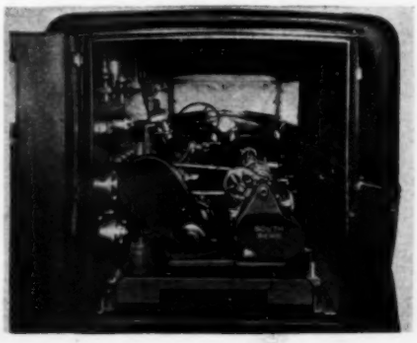
Headwall for Spi-Cor Culvert Pipe

the lower inside surfaces of the side aprons. The side aprons and the bottom apron are securely locked together by a cast iron double dovetailed key which engages slots cast in the bottom apron and in the side aprons.

The Spi-Cor culvert pipe consists of two members, the pipe member and the cuff member. The corrugations are spiral and the connection between members is made by screwing the pipe member into the cuff member one complete turn. The Spi-Cor culvert pipe is a short length, light weight cast iron pipe, molded in a spiral and corrugated form.

A Mobile Machine Shop

A mobile machine shop developed by the experimental engineers of the South Bend Lathe Works, South Bend, Ind., is illustrated. The unit pictured is a small unit, set up for experimental purposes. In the delivery portion of a stock model "A" Ford panel delivery truck, a 9-in.



South Bend Mobile Machine Shop

Junior bench lathe has been installed. The lathe is attached to a movable base in which there are two rollers that run on strips of angle iron sunk into the regular floor of the truck. A simple locking device holds the unit securely in place inside the truck when it is not in use. After unlocking, a very light pull with one hand will draw the unit out in working bench position. Two hinged adjustable legs drop down to support the headstock end. In less than five minutes the lathe can be made ready for operation.

In the experimental unit shown, only the lathe and lathe attachments are used. But the feasibility of the plan is demonstrated and a complete machine shop can be arranged by following the same idea. Included in that could be a drill press, a grinder, vises, electric drills and various necessary small hand tools.

Adams Introduces New Retread Mixer

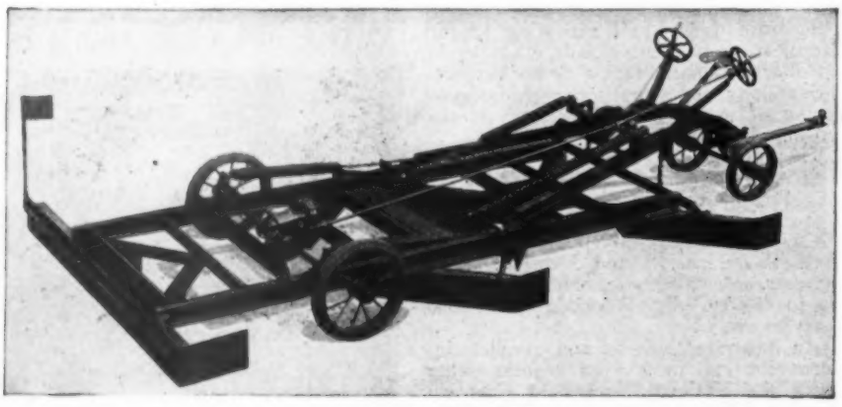
For several years, Adams multiple-blade road maintainers have been widely used by highway officials and contractors for the mixing of bituminous materials, such as asphalts, tars and road oils with gravel, stone and slag aggregates on mixed-in-place work. J. D. Adams Co., Indianapolis, Ind., now offers a new machine, Adams retread mixer, which is similar to the Adams road maintainer but has several new features which make it even more desirable for use on mixed-in-place bituminous surfacing.

The retread mixed blades are 12 in. wide and are set to provide sufficient throat room for a 2½ to 3-in. course of material. Three sets of blades set at a 45 degree angle work the material, which has been previously "shot" with bituminous binder, back and forth three times in one trip, thoroughly mixing the bitumen with the aggregate. The long rear blade, then evenly spreads the material to the required thickness in the same trip.

The mixing blades are rigidly mounted on the main frame, cut in the same plane, and are set to just skim the base so as to pick up and mix all of the material. The rear blade is adjustable 3 in. vertically so as to spread the course to the required depth, and is in three sections which can be adjusted to spread the mix with a slight crown, if desired. All right hand blades have forward extensions to prevent the mix spilling out of line.

The advantages claimed for Adams retread mixer are that it mixes and levels the material in one operation and that it produces a smooth riding surface free from waves and irregularities because of its long wheel base and rigidly mounted blades.

A descriptive folder and complete information on Adams retread mixer will gladly be sent on request to J. D. Adams Co., Indianapolis, Ind.



Adams Retread Mixer

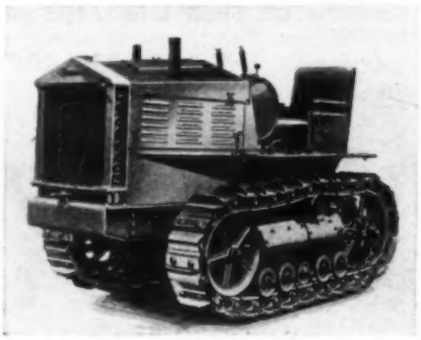
The New Cletrac Model 15 Tractor

The Cleveland Tractor Co., Cleveland, Ohio, has added to its line a new tractor known as the Model 15 Cletrac. This new unit is powered by a 4-cylinder, 4-cycle, water-cooled, L-head engine having 4-in. bore by 4½-in. stroke cylinders cast enbloc.

Ignition is by a high tension Eisemann magneto with impulse starter. Speed is regulated by a flyball governor attached to a butterfly valve at the point of carbureter intake. The fuel tank, of 20-gal. capacity, is mounted back of the dash. A 3-gal. tubular radiator is used.

A Borg and Beck single-plate push-type clutch of 11-in. diameter is used. Transmission speeds are 1.95, 3.05, and 4.37 m.p.h. respectively forward and 2.2 m.p.h. in reverse, all at the governed speed of 1250 r.p.m.

Steering is accomplished by the effect of the motor through planetary compensating gears. As pressure is applied to either side of the steering brake drums by the steering gear, it slows down the track on the side to which pressure is applied, causing the opposite side to speed up.

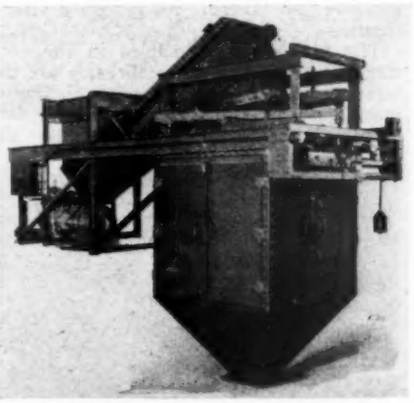


The Cletrac "15"

Overall length is 93½ in., width 50½ in., and height at radiator cap 52½ in. Ground clearance is 13½ in. and center to center between tracks is 40 in. The turning radius is 8 ft. A power pulley or power reduction take-off is supplied as extra equipment. Ratings are 15 hp. at the drawbar and 22 hp. at the power pulley.

Scale for Automatic Weighing of Bulk Cement

A scale for the automatic weighing of bulk cement from bin to mixer, truck or railroad cars is a recent product of the Richardson Scale Co., Clinton, N. J. The scale is made either in weighing hopper or weighing conveyor type according to plant conditions and job requirements.



Richardson Screw Feed Automatic Scale

The automatic weigher illustrated is of the automatic hopper dumping and self-registering type. Automatic conveyor type scales are available where conditions dictate this style.

The bad effects of a "flood" from the bin are eliminated by the double screw feeder which is an integral part of the scale. There are two conveyors—one a large one to feed the main part of each weighing and a small one to feed the final "make weight."

The main screw conveyor is of ample size and speed for quick feeding. Being inclined at a considerable angle from the horizontal this conveyor takes the "run" out of the cement and delivers it quietly and under control through a dustproof chute into the weighing hopper which is also enclosed in a dustproof housing having suitable access doors.

The main screw feeder is driven by motor through an enclosed worm speed reducer which in turn drives a pair of heavy cast bevel gears that drive the conveyor through a slip clutch.

When the main screw feeder has delivered approximately 90 per cent of the individual weighing or batch, it is stopped by the action of an electric switch in the control box. The small auxiliary screw is mounted immediately underneath the main feeder and feeds in what is known as the "dribble stream" or final small flow necessary for accuracy. This smaller screw is driven by its own speed reducer, motor and gearing, for it continues to run after the main screw has stopped, the dribble screw in turn being stopped automatically when the exact weight of cement has been delivered to the scale weighing hopper. Both the main screw and the dribble screw are enclosed in their own dustproof tube casing.

The scale is of standard construction with hanging weights for part of the load

and a weigh beam with sliding weight for the remainder at one end of the system and the weigh hopper for the cement is suspended at four points at the other end. Weights are placed on the weight carrier and the poise is set for any predetermined weight within the range of the scale.

Lorain 6 Point Cab

A new, smart looking cab containing many unusual features, that contribute both to the efficiency and comfort of the operator, has been announced by The Thew Shovel Co., Lorain, O., as standard equipment on their complete line of Lorain shovels and cranes. It is known as the Lorain 6 Point Cab, as it offers six distinct advantages—appearance, accessibility, visibility, ventilation, protection and safety.

A radical change in appearance is achieved by the substitution of curves for angles throughout the entire construction. The roof, rear corner posts, back and side panels all blend together to give a most decided streamline appearance. Careful consideration has been given to the design and location of the cab doors from the standpoint of ventilation, accessibility and visibility. Doors, all sliding from the inside, are placed at strategic points at both back and sides.

The rear of the cab consists of three full length sliding panels on three separate tracks. These three doors may be nested together, making it possible to open up any two-thirds of the back from floor to roof. Such an arrangement allows the

New Cab for Lorain Shovels and Cranes

operator a full view through the rear of the unit. It permits easy access to the entire motor for adjustment and repair work and affords much more room to work in. By means of a special locking device the doors are held in any position desired and prevents them sliding back and forth or when completely closed may be securely locked from the inside.

The method by which any two-thirds of the back may be opened from floor to roof greatly increases ventilation for the cooling of the cab. To further increase accessibility and ventilation, the doors of side panels are placed at each end of the motor. The motor, in turn, is placed so that the hot engine air is blown away from the operator. A larger roof hatch is located directly above the motor, making a total of 108 sq. ft. of wall space which may be opened up for ventilating and cooling purposes.

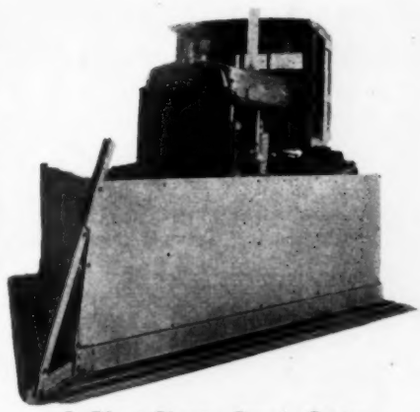
The cab of a shovel or crane presents one of the best mediums for the owner to advertise his name and service to the public. Each of the two sides of the cab offer two full size panels for prominent display advertising unobstructed by doors. The three sliding panels making up the back so nest together that the center panel carrying the owner's advertising is always on the outside in plain view regardless of its position. This is a decided advantage over the old method whereby the value of this space is lost when opened up.

In this all-steel cab, stronger construction and heavier materials are used throughout. Rear doors are of extra heavy gauge steel and the tracks are used welded to the curved roof section serving as a reinforcement along bottom edge of roof for full width of the machine. Shoulder pads have been added to the rear counterweight casting which extend up and around and protect the rear curved corner posts, preventing damage to cab. These are easily removed when absolutely minimum clearances are required.

Two hinged doors at the front of the cab make it possible to completely close and lock up the turntable, giving protection from both theft and weather. Such important items as dust covers for machinery, gear guards, non-skid protective floor plates and cab cut-off on right to eliminate blind spot when swinging all increase the safety and efficiency of operation. Not even the smallest details have been overlooked, as is evidenced by placing tool box, pinch bar rack and clothes closet in convenient places.

Tractor Driven Cutter for Clearing

A brush cutter for use with a tractor is now being manufactured by the LaPlant-Choate Mfg. Co., Inc., Cedar Rapids, Ia. The machine shaves the brush and timbers off at ground level by means of a V-type cutting edge which gives a slicing effect in cutting brush and trees. The cutting edges are of crucible steel and fastened to the bottom of the wedge-angle with heavy bolts. The blade, when it becomes dull or nicked, can be hammered out on a piece of heavy iron such as a railroad rail and then filed to sharpen it. There is very little to wear or break on this machine. Practically every part is a forging and can be straightened out in any blacksmith shop. The cutter is provided with three screw regulated shoes, one at the front and one on each side for regulating the cutting height of the cutter. Two long runners are provided for transporting the cutter from place to place and are operated by a hand-operated hydraulic jack.

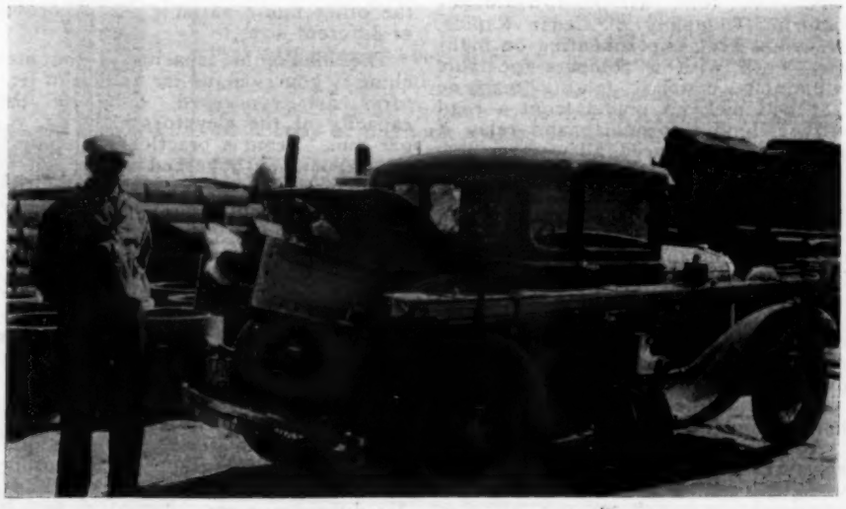


LaPlant-Choate Brush Cutter

The machines are now ready for distribution for use on the "Caterpillar" Sixty and Thirty tractors. The brush cutter for the Sixty has a cutting width of 12 ft., while the Thirty has a cutting width of 9 ft. The Sixty is stated to have operated successfully in cutting soft poplar trees as large as 18 in. in diameter. The size of the brush to be cut will depend upon its hardness and density. The speed of cutting varies somewhat with the size of the trees. In brush and small timber the Sixty is stated to have averaged from 10 to 12 acres a day.

Machine for Testing Culvert and Sewer Pipe

A testing machine designed for quick setting up and dismantling and for easy transportation for field use has been placed on the market by the Anderson Engineering Sales Co., Statler Bldg., Boston, Mass. It is stated the machine can be erected in 15 minutes ready for making tests and can be dismantled in 10 minutes for transportation. The overall size is 1 ft. by 5 ft. by 10 ft. and the net weight plus the dial is 600 lb. The machine has a 50,000-lb. loadometer. The machine will handle up to 42 in. 4 ft. pipe. For larger sizes a block and falls rigging should be used. The testing machine also is manufactured as a complete assembled unit with a patent unloading track and can be used in testing concrete beams, blocks, bricks and vitrified building products.



Bratt's Portable Pipe Testing Machine

New Heavy Duty Hydraulic Hoist Unit Announced

The Perfection Steel Body Co., Galion, O., announce the production of their heavy duty hydraulic hoist for the Ford and Chevrolet with a complete line of steel bodies.

This hoist is presented as a distinctly rugged heavy duty job designed and built for "over capacity" service. Besides its

Perfection Heavy Duty Hydraulic Hoist

sturdy construction, the outstanding feature is the "cushion drop" mechanism or automatic control which gives it the advantage of dropping the body, either full or empty, very rapidly to the riding position, yet without "slamming" the frame. The "hydraulic cushion" becomes effective when the body frame comes to within several inches of the chassis, then it eases down to the full riding position.

This hoist is stated to raise the load to a full 50° angle in less than four seconds and returns it by controlled gravity to any intermediate position.

Its safety feature—an automatic valve mechanism, holds the body in any raised position in case the power fails, engine stops, or even if power clutch is released accidently. The loaded body will also "ride" in any raised position on this hydraulic cushion.

Similar units for larger capacity trucks are in process. Units for Ford and Chevrolet mounting are now ready with standard and special purpose steel bodies.

Cedar Rapids Road-Mix

For some time past the Iowa Manufacturing Company of Cedar Rapids, Iowa, has been experimenting on highway work with a compact, portable bituminous material mixing machine that will pick up gravel from a road surface, bind it properly and relay it as a dustless, surfaced, all weather, low cost road.

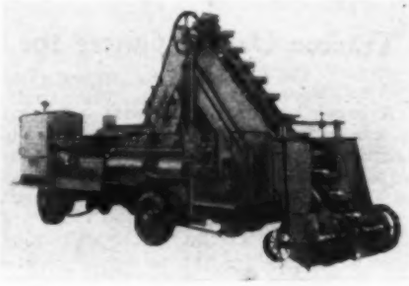
In operation, it is necessary that the gravel road to be improved be first scarified, then the gravel bladed into a windrow along the roadway. The mixer follows along the windrow, picks up the material, mixes it in a continuous pugmill with the road oil, and deposits the mixture in another windrow at the rear. This machine consists of five principal elements:

1. The prime mover—a Climax 85-hp. 4-cylinder gasoline engine.

2. The pickup assembly—a bucket elevator with feeding ribbon mounted on the lower shaft, which has a capacity of 1.30 cu. yd. per min., allowing a safety factor of 63 per cent.

3. The batching device—a batcher which trips when the specified amount of material by weight has dropped into it from the elevator. The batcher actuates a piston pump which forces a definite quantity of road oil into the spraying manifold of the pugmill. The batcher is seen at the top of the elevator. The oil pump is on the other side of the machine near the batcher. One 850-gal. tank for road-oil storage mounted on side of the pugmill. Tank is heated by kerosene burners.

4. The pugmill-mixing is accomplished by a continuous pugmill, with a length of 17 ft. and volumetric capacity, to the level which the material assumes under local conditions of mixing time, of 45 cu. ft. Fig. 3 illustrates the pugmill mixing action, with the spraying manifold for the hot road oil. The material enters at the upper end of the long pugmill at atmospheric temperature and is combined with the road oil at about 200 deg. F. and the mixture leaves the lower end to be deposited in another windrow on the base. The speed of the elevator and the speed of the pugmill paddles bear a constant relationship to the speed of the motor, which in itself is constant.



Cedar Rapids Road-Mix

5. The traction assembly—the driving wheels of the machine are connected to the motor by a clutch system which allows four road speeds: 1.67, 2.67, 5.0 and 8.0 ft. per minute. This latitude of road speeds is necessitated by the sizes of windrows which are encountered on various projects when the final mat is of different thicknesses.

The production in cubic yards per hour is of more significance than the production in feet per hour, since the first figure may remain constant and the other figure variable for windrows of different sizes.

The maximum capacity of the machine is governed, as far as design features are concerned, only by the capacity of the elevators—1.30 cu. yd. per min. From a practical standpoint, the capacity is governed by the set of the pugmill blades, or, in other words, by the desired mixing time in order to give satisfactory mixing action.

With the production figure given, the mixing time for a given unit of material is 93 sec. The Bureau of Public Roads, Division of Management formula for mixing efficiency of pugmills gives an efficiency index of 193. (California 2500-lb. asphaltic-concrete pugmills give but about 120 on a 45-sec. mix.) Additionally, uniformity determinations on the mixed material from the pugmill show a degree of uniformity which substantiates this index figure. No difficulty is encountered in putting out a homogeneous black mixture when the road-oil content is kept at the figure ordinarily used in the manipulation method of mixing.

It has been stated that additional manipulation by blade units is required in order to develop the floor of the base for bond to the top wearing-course. The degree of manipulation is about one-sixth of that required in regular manipulation mixing. Because of the cold material, it is expedient to raise the road-oil temperature to about 200 deg. F. in order to properly incorporate the road oil. The most important aspect of the machine, and that to which every engineer should direct his attention, is the bringing in of high-cost construction refinement into low-cost bituminous work.

A Springless Joint Filler

A springless pot that is claimed to greatly simplify the operation of filling cracks or joints has been developed by Littleford Bros., 454 East Pearl St., Cincinnati, O.

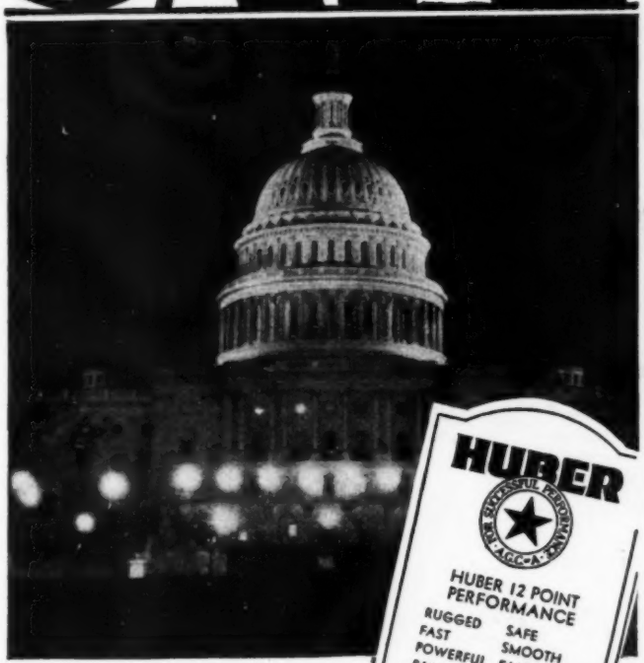
Crack and joint filling pot No. 86-B has a rated capacity of 2½ gal. Flow of asphalt is controlled by a weighted valve that can be easily opened or closed. The valve seat at the bottom of the pot is made of cast iron and is heavy enough to be of material assistance in retaining heat to prevent congealing of bitumen at this point. The pot is constructed of sheet steel with strongly welded seams and can be thoroughly heated in a fire without injury to it.

The top of the pot is the proper height to go under the draw-off cock of an asphalt heating kettle. Discharge nozzle can be changed to ½-in., ⅝-in. or ¾-in. opening.

For complete description of the crack and joint filling pot, write Littleford Bros., Cincinnati, O.

Littleford Springless Joint Filler

SAFE



HUBER

HUBER 12 POINT PERFORMANCE

RUGGED SAFE
FAST SMOOTH
POWERFUL FAITHFUL
BALANCED LASTING
FLEXIBLE ACCURATE
PROFITABLE PRACTICAL

FOR THE ROADWORK *of the* NATION

HUBER'S ability to handle many types of road work makes it an extremely valuable and profitable piece of equipment to own. With Huber, one machine does the work of several, at but a fraction of the cost. Contractors, State Highway Departments, Cities, Counties, Townships, Municipalities—all are using and endorse Huber Motor Rollers.

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Here is a book that will prove handy to every contractor. Contains complete, up-to-the minute information on THOR Air Compressors, Rock Drills and Contractors Tools. Shows the number of tools each size compressor will operate. Fully explains and illustrates the construction features of compressors that will interest every user and buyer of air compressors.

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Kindly send me your Handbook on Air Compressors, Rock Drills and Contractors Tools.

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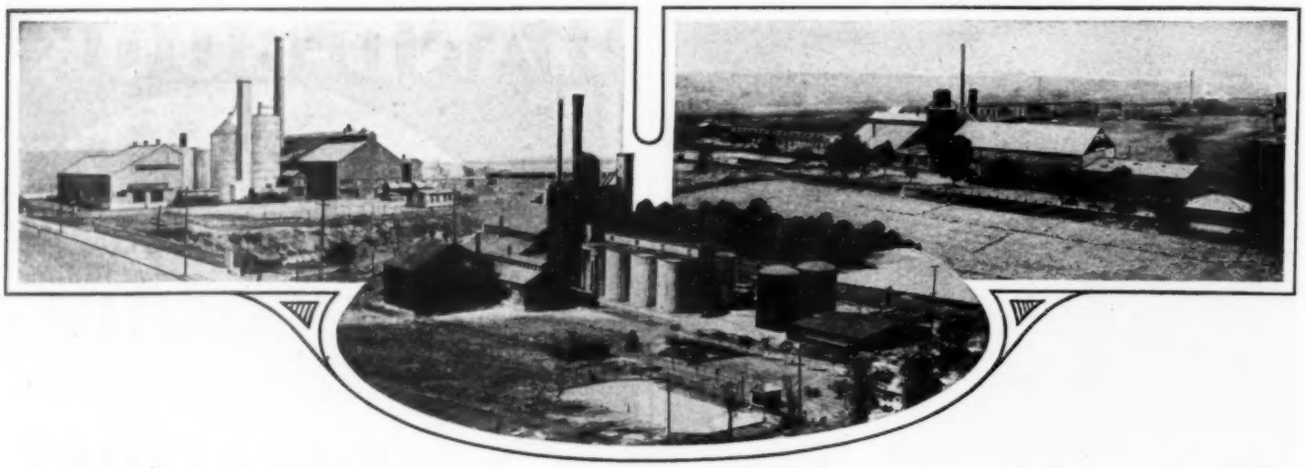


View of Three of the Plants of the Philadelphia Quartz Company

Philadelphia Quartz Co. Begins Its Second Hundred Years

While most men and business organizations are talking about the first hundred years, there is one well known firm which is using the phrase the *second century*, for the first century for them has passed into history and they are looking toward the next.

For one hundred years the written communications from the Philadelphia Quartz Company have borne the quaint salutation, "Respected Friend." Although times have wrought many changes, those who have guided the company's affairs during these years have never seen fit to relinquish this salutation. In this simple phrase one senses that dignified courtesy with which Joseph Elkington, God-fearing and diligent Quaker (the fifth of his family in America), endeavored to align his business practices.

In planning for the future in purpose, in discovery and in methods, the management of this company entering upon their second century of service, are chartering their course by one dominant note which has been with them from the beginning, the wise and kindly admonition of Joseph Elkington to his son, "to continue to dwell under a proper regard for the best things."

On July 21, 1831, a factory was founded by this same Joseph Elkinton, Quaker, in Philadelphia for the manufacture of soap and candles. For thirty years soap and candles were the main output, but in 1861 silicate of soda was becoming commercially important, and gradually the growing production of soluble silicates entirely crowded out the other items, until in 1904 the manufacture of soap was discontinued.

A combined store and dwelling at 377 South Second Street, was the first location of this business where barter and exchange recorded such transactions in the books as coffee, cordwood, coal, sand, grease, "banilla," carpet, etc. Also foodstuffs, such as butter, pork, flour, etc. For almost twenty years Joseph Elkinton conducted this business himself, then he was joined by his sons, Joseph S., Asa and Thomas.

In January, 1862, the founder withdrew from the company, leaving the business to be conducted by his sons, Joseph S. and Thomas. A few months later the first of the company's informative bulletins appeared, which have since become familiar wherever silicate is used. In 1864 a new factory was set up at 9th and Mifflin Streets. This was the first of nine plants which have since been added to the Philadelphia Quartz group. A partnership was then formed to trade as Philadelphia Quartz Company, the first time the present company title was used. This new plant was to specialize on silicate of soda, the soap business being continued for some years at the old plant under the Elkinton name.

Charles Goudy, a soap maker from Marshalltown, Iowa, was engaged as a salesman for the company in 1876. He employed a novel method of demonstrating the use and value of silicate in soap factories and was instrumental in greatly increasing sales. Goudy, it is said, traveled with a miniature soap plant with which he could make samples of silicated soap in the presence of the buyers and he also would go into factories for large scale demonstrations.

With the introduction of the corrugated shipping boxes in the early nineties a large demand for silicate as an adhesive was created. Simultaneously came the use of silicate for laminated fibre sheets and wall board. When it was learned that the proportions of ingredients could be varied to produce widely different properties, useful applications for silicate in many other industries were progressively discovered and this is still going on. Its application in the highway field is for the curing of concrete.

William T. Elkinton, present chairman of the board of directors, joined the organization in 1879. His brother, Alfred C. Elkinton, now president of the Philadelphia Quartz Company of California, came shortly after. So it is that with these men still at the helm, the beginning of the second century has been reached under the direction of the third generation in the founder's family.

The pioneering spirit of the company still dominates, as it introduces for the first time in commercial form a new industrial alkali, sodium metasilicate, and the management believes it is within reason to expect developments and improvements in silicates of soda in the second century to equal or surpass those which marked the first.

Because silicate of soda is a low priced commodity, its place in industry depends upon the refinement of economy both in production and delivery. For this reason, plants must be located close to markets. The Philadelphia Quartz Company now has nine plants located, after scientific study not only of raw material sources but most favorable delivery conditions, at Chester, Pa.; Anderson, Ind.; Baltimore, Md.; Gardenville, N. Y.; Kansas City, Kansas; Rahway, N. J.; St. Louis, Mo.; Utica, Ill., and Berkeley, Calif., the last, the Philadelphia Quartz Company of California.

General headquarters of the company are located at 121 South Third Street, Philadelphia.

In commemoration of their centennial this company has issued a most attractive little brochure entitled Beginning Another Century, reminiscent of the beginnings of industrial America, and containing as illustrations some quaint wood-cuts. It is a fitting testimony to Joseph Elkinton and his business principles so well expressed in the phrase, "to dwell under a proper regard for the best things."

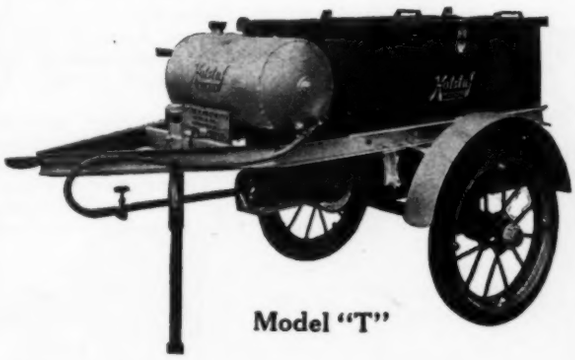
R. D. Bean Promoted

According to recent announcement R. D. Bean, formerly manager of the engineering development department of The Brown Instrument Company of Philadelphia, has been made chief engineer of that company.

Mr. Bean's extensive field investigations covering many applications of Brown industrial measuring instruments have won for him wide acquaintance and his numerous friends will be glad to hear of his promotion.

Hotstuf
TRADE MARK REG.

Asphalt Heaters



Model "T"

The Only Heater With the Patented Elevated Melting Chamber Feature:

QUICK ACTION. The hottest flame is under the melting chamber and as fast as the asphalt melts it runs down into the melted chamber, leaving the melting surface clean of sediment and in direct contact with the cold material. The long heat travel passes under the already melted material heating it up to the desired working temperature.

NO COKING. The elevated melting chamber eliminates overheating the already melted material and forming a coke with the sediment. This cannot be prevented in the round bottom kettle.

NO WAITING. The melted asphalt never comes in contact with the cold asphalt, so that reloading of the heater never lowers the temperature of the hot asphalt.

MAXIMUM EFFICIENCY. The absence of coke and melted asphalt on the melting surface eliminates an insulation through which the heat must travel to reach the cold material to be melted, giving maximum efficiency in melting and heating and prevents burning out of kettle bottoms.

DISTRIBUTORS IN PRINCIPAL CITIES

Mohawk Asphalt Heater Co.

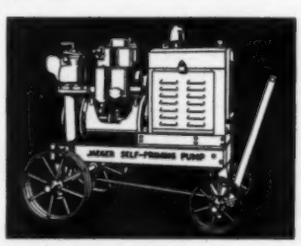
SCHENECTADY NEW YORK

The DEPENDABLE PUMP *for* Road Contractors!

JAEGER TRIPLEX ROAD PUMP

The fully self-oiling pump with roller bearings on all shafts, steel cut gears running in oil, detachable cylinder block and removable cylinders, specially hardened pistons, accessible horizontal design and automotive truck.

Engineered **to give unfailing supply where water shortage costs money...*serviced* from over 100 Jaeger stations coast to coast...*tested* and *proven* on over a thousand road jobs.**



HEAVY DUTY 10S MIXER 50% stronger, ½ ton lighter, short coupled, direct driven, ideal for bridge and culvert work.

IMPROVED SELF-PRIME CENTRIFUGALS. New performance, reliability and low prices. All sizes for drainage jobs.

GET THIS CATALOG—PRICES!

THE JAEGER MACHINE COMPANY,
223 Dublin Avenue, Columbus, Ohio

Send full information on [ ] Pumps, [ ] Non-Tilting Mixers, [ ] Improved Tilters, [ ] Timken Screw Thrust Hoists.

Name _____

Address _____

_____

R. W. Andrews of Blaw-Knox Company Promoted

The appointment of Roger W. Andrews as vice-president and director of Blaw-Knox International Corporation has recently been announced. It is stated that Mr. Andrews will reside in Paris and will be in charge of the company's European activities, which for the past few years have been growing considerably. Prior to this change Mr. Andrews was assistant to the president of the company. He will take the place left vacant by the death of C. T. Clack, who recently passed away in Dusseldorf, Germany.

Roger W. Andrews, Vice-President of Blaw-Knox Co. in Charge of the Company's European Activities

Before joining the Blaw-Knox organization Mr. Andrews operated his own company under the name of Andrews-Bradshaw Company, specializing in power plant and engineering equipment, principally in the manufacture and world wide distribution of steam, gas and air purifiers under the trade name of "Tracyfiers." The first part of 1928 his company merged with Blaw-Knox, and Mr. Andrews was made manager of the Traceyfier division of the company, until he was appointed assistant to the president in the spring of 1929.

Mr. Andrews is a member of the Engineers' Society of Western Pennsylvania and the American Society of Mechanical Engineers.

Blaw-Knox manufacture a wide variety of road building machinery, including concrete finishing machines, steel forms, automatic measuring devices, bulk cement plants, proportioning plants, trukmixers, etc.; as well as steel plant equipment· power plant specialties; standard steel buildings; rolls and rolling mill equipment, etc.

New Representatives Named by Lukenweld, Inc.

Dravo Doyle Company has been appointed by Lukenweld, Inc. (division of Lukens Steel Company, Coatesville, Pa.) to represent them in the Pittsburgh territory.

Because of its extensive experience in sales and engineering work for prominent manufacturers of machinery and equipment, the Dravo Doyle organization is said to be well equipped to serve Pittsburgh industries in connection with sales and engineering work on Lukenweld construction.

Another territory representative to be appointed by this steel products manufacturer is W. R. McDonough & Company to serve the Cleveland district.

It is reported that many manufacturers of machinery and equipment are using Lukenweld products, which are known as Lukenweld Construction, for housings, frames, bases, beds, gear cases and other machinery and equipment parts, which are designed and manufactured by gas-cutting, forming and arc welding of rolled steel.

McKinlay of AC Spark Plug Receives Promotion

President Harlow H. Curtice of AC Spark Plug Company, Flint, Michigan, recently announced the appointment of Charles Wesley McKinlay as chief development engineer to succeed Joseph Zubaty, who is leaving after eight years of service for an extended stay in Prague.

Mr. McKinlay started in the automobile industry 25 years ago as engine-designer for Pope-Toledo. At that time automobiles were steered from the right side, with the gear shift located on the outside of the car. He is credited with designing the first automobile that went into production with the center gear shift.

Other developments credited to Mr. McKinlay are the two door sedan, commonly known as the coach; the first production touring car, with four doors and cowl; he saw the advantages and was first to adopt the four cylinders en bloc type of engine; set precedent by approving and adopting the Bendix starter, and originated the idea of carrying spare tire on rear of cars and designed spare tire carrier.

For five years he was chief engineer at the Willys-Overland company and from 1920 to 1925 was chief engineer for the Tillotson Carburetor Company. For the past six years he has been with the AC company and prior to his promotion was assistant chief development engineer. He has a wide knowledge of the internal combustion engine and is an authority on lubrication devices, instrument board panels, speedometers and other instruments.

Mr. McKinlay was born in Toledo and attended Cornell University.

Charles Wesley McKinlay, Chief Development Engineer of AC Spark Plug Company

W. L. Beck Joins Independent Pneumatic Tool Company

Independent Pneumatic Tool Co., 600 W. Jackson Boulevard, Chicago, has recently announced the appointment of William L. Beck as manager of their distributors division.

The Independent company manufactures air compressors and contractors' tools and Mr. Beck will direct the activities of the firm in contacting the dealer trade in connection with the development of a re-sale organization for compressors and tools.

Because of his long association in this type of work Mr. Beck has a wide acquaintance among contractor equipment distributors. For five years he was with the Gardner-Denver Company, two years of that time as eastern manager. He left them to join the Harnischfeger Corporation and spent two years traveling for them throughout South America as manager of sales. On his return to America he was retained by the Austin Machinery Corporation in a consulting capacity in the development of their sales policies.

Mr. Beck, who is a graduate engineer, also has as a background for his sales work 7 years' mining experience. He has established his headquarters at the general offices of the company in Chicago.

News Notes from Hercules Motors Corporation

Charles P. Weekes, vice-president in charge of eastern sales for Hercules Motors Corporation of Canton, Ohio, recently sailed for Russia in the interest of his organization. Mr. Weekes expects to be away some time.

The eastern office which is located in the Chanin Building, New York, will be under the direction of A. B. Wehling during Mr. Weekes' absence.

A new member has been recently added to the Hercules personnel. W. W. Cromley, for many years identified with the internal combustion engine industry, has joined the staff of sales representatives of the country, and Harry E. Blasingham has been appointed general purchasing agent in charge of all purchases and stores.

Hibbard-Eichman-Smith, Inc., Cleveland, Ohio, distributors for Rex pumps and mixers, Erie bins, Mundy hoists and derricks, General excavators, and other leading lines of road building and construction equipment have just issued a new 240 page AGC catalog listing the products of seventy manufacturers. The index contains five hundred items.

Cement Gun Construction Company announces the removal of their New York office to 1169-1171 Woolworth Building. The telephone number has been changed to WOrth 2-5798.

Any grade of material—Any temperature—with

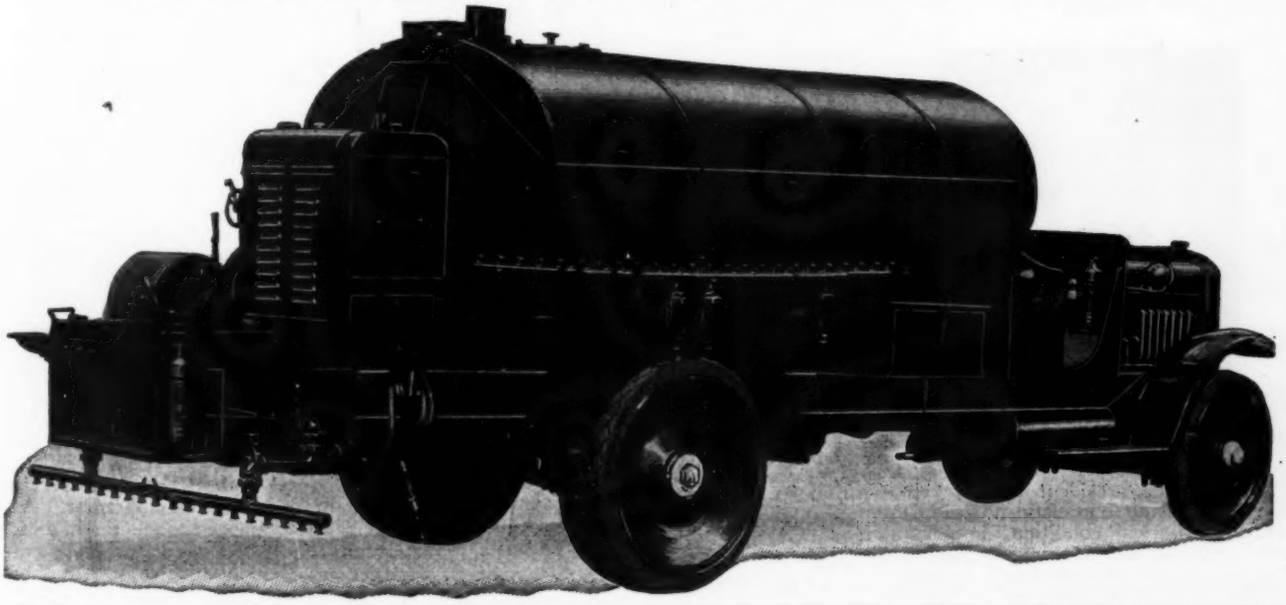
South Bend Dual Drive Bituminous Pressure Distributor

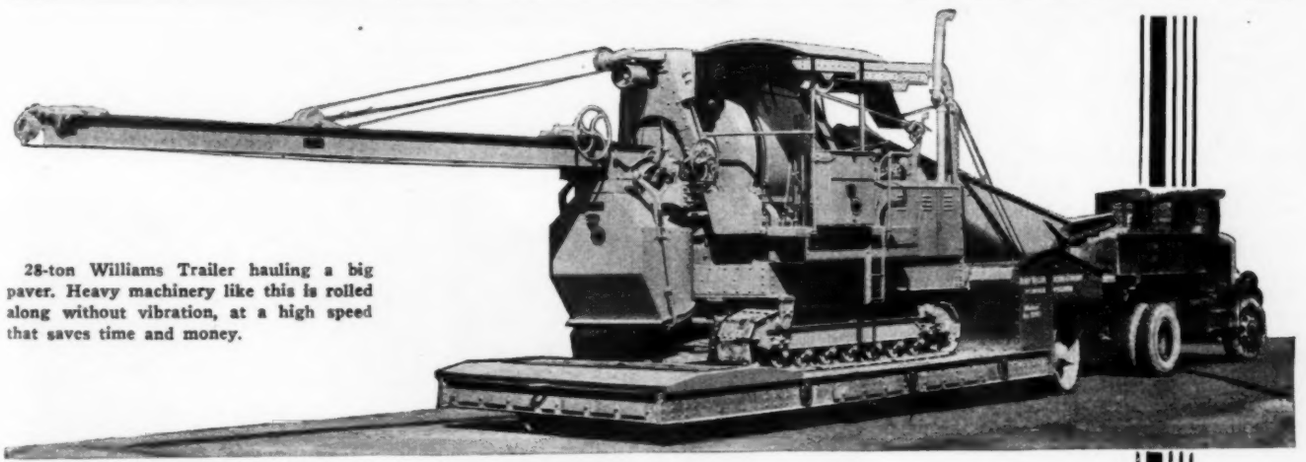
Whatever the requirements of your job, South Bend Distributors will meet them. Fast handling, dependable, and economical to operate, they have an outstanding performance record—delays due to repairs or adjustments seldom occurring on jobs when "South Bends" are used.

Let us tell you more about them.

Manufactured by **MUNICIPAL SUPPLY COMPANY, South Bend, Indiana, U. S. A.**

For Canadian Trade: **Manufactured by Bickle Fire Engines, Ltd., Woodstock, Ontario, Canada**





28-ton Williams Trailer hauling a big paver. Heavy machinery like this is rolled along without vibration, at a high speed that saves time and money.

Haul *Bigger Pay Loads* - - at a new low cost

YOU'LL get a new idea of efficiency in heavy hauling, when you talk to users of the WILLIAMS "Arch-Girder" Trailer.

They are hauling *heavier pay-loads*— faster — with less gas. Takes less time to load— and costs less to keep the trailer in A-1 shape.

Get the facts on *the original trailer built for greater capacity without added weight.* Write us.

G. H. WILLIAMS COMPANY
617 Haybarger Lane, Erie, Pa.
Branch Offices: *New York, Pittsburgh, Cleveland, Chicago*

WILLIAMS
TRAILERS—BUCKETS

355

Continental Motors Holds Field Sales Meeting

The sales and engineering representatives of the Continental Motors Corporation recently held their regular quarterly meeting at the Detroit offices of the company.

The field service of this company is the outgrowth of thirty years of engine building experience, and involves the analysis of engineering problems of design and production which enter into the application of gasoline engine power to machinery for industry.

Wm. R. Angell, President Continental Motors Corp.

W. R. Angell, president of the corporation, sounded an optimistic note for the return of normal conditions in general, and regarding the corporation said that it is in a better position than ever before to lead in the gasoline engine building industry, due to its long history of successful engine manufacture, its strong financial position and cash resources, and the opportunities afforded during the last several months of lowered activity to effect changes and improvements in administration.

L. J. Kanitz, general sales manager, spoke to the field men of the engineering department, which he said consists of a group of men many of whom have served the organization throughout its history. He stated that development and tests had been completed of a number of new models of the Red Seal engines which will soon be introduced to the market, which will cover an even wider range of power applications than the present line.

Following a visit to the engineering and testing laboratories, the meeting was concluded with a dinner attended by the field men and the executive heads of the home offices.

Rubber from Goldenrod

A news note from the "Century of Progress" Exposition (the buildings for which are rapidly coming into view on the lake front in Chicago), states that a field of forty-two different varieties of goldenrod will be used by Thomas A. Edison and Henry Ford for the purpose of demonstrating the process of extracting rubber from goldenrod.

It is said that the breeding of goldenrod, the extraction of sap by hydraulic pressure, the chemical processing of the rubber and the manufacture of rubber articles are contemplated by Edison and Ford as a demonstration at the Fair of what is being done at Fort Myers, Florida, and Dearborn, Michigan along this line.

John Stephen Sewell, president of the Alabama Marble Company, is director of exhibits for the Chicago 1933 World's Fair. The first actual check for exhibition space from a manufacturer was sent in by the Hammond Clock Company of Chicago, according to report.

Veteran Machinery Manufacturer Leaves Estate to University

Recent news items carried word of the death of Frederic C. Austin at Pasadena, California. Mr. Austin was the founder of the F. C. Austin Manufacturing Company, Harvey, Illinois, and the Austin equipment which has contributed much to good road building is well known to the entire highway industry.

A little over two years ago Mr. Austin announced a gift of a piece of Chicago loop property to Northwestern University, said at that time to be valued at approximately $3,000,000. The gift was to be used by the University for the foundation of scholarships for the education of young men, the unique feature of this being that it was to be confined to students fitting themselves for a place in the business world, rather than for one of the professions.

Wishing to see the plan put into operation during his lifetime, immediate funds were placed at the disposition of President Scott of Northwestern University and before Mr. Austin's death it was his pleasure to meet personally many of the boys who were receiving their college education under the Austin Foundation. When the plan was started it was thought that ten students would enter the university each year on these scholarships, making a total of forty Austin boys on the campus at one time.

When Mr. Austin's will was filed for probate it was found that his entire estate, valued at $280,000, was to be added to the original gift. In the will he made no provision for heirs, explaining he had already provided for them.

Frederic C. Austin

Quoting from an item regarding the will, it specifies that the income from the fund be used for scholarships to aid "persons trying for executive positions in large business and industrial enterprises and excluding those who follow the professions of law, medicine, theology and music."

Mr. Austin was born on a farm near Skaneateles, New York, June 2, 1853. He came west when a young man, traveling for his uncle H. W. Austin, a hardware manufacturers' agent, and at one time was a partner of Goulds, Austin and Caldwell. Since 1920 he has devoted his time to his investments. Burial took place at Rosehill cemetery, Chicago.

Shearer on Sales Staff of Keystone Portland Cement

Announcement has been made by the Keystone Portland Cement Company of Philadelphia of the appointment of Charles E. Shearer as assistant sales manager of the company.

For a number of years Mr. Shearer was connected with the Atlas Portland Cement Company in Philadelphia and Chicago, and after the sale of that company to the United States Steel Corporation he joined the Pennsylvania-Dixie Cement Corporation.

In addition to other duties, it is stated, that Mr. Shearer will give attention to the promotion and sale of Keystone's new product Velroca, a high-early-strength Portland cement.

Osgood Improves New York Sales Facilities

The Osgood Company announces the purchase of site and building located at 1038 Hoyt Avenue, Ridgefield, New Jersey, in order to assure their customers of permanent, continuous service in the Greater New York Sales and Service Branch of this Ohio manufacturer. Arrangements have been made for a direct telephone line to New York whereby customers in Manhattan, Bronx, Brooklyn and Queens may communicate with Ridgefield at local rates. They invite their friends and patrons to visit them and inspect their new quarters.

Fuller & Smith & Ross, Inc., Cleveland advertising agency, have accepted with regret the resignation of P. W. Murphy as secretary-treasurer, director and stockholder of their company. Mr. Murphy has had 22 years of activity in the agency business and it is stated that he is retiring to have time for rest and to give to other interests of strong appeal. His former financial duties will be assumed by Francis G. Hubbard, vice-president, at New York. Sidney D. Mahan, vice-president, has been appointed manager of the Cleveland organization.

Billett Made Secretary of Toledo Scale Company

Frank K. Billett, who has been connected with the Toledo Scale Company for the past ten years, eight of which he has been head of the cost accounting department, has recently been appointed secretary of the company.

Mr. Billett joined the organization as enameling room clerk in 1920, and his recent appointment as secretary is a high tribute to his ten years of service.

Little Giant Products, Inc., of Peoria, Illinois, has absorbed the Lee Trailer & Body Company, Plymouth, Indiana, according to recent announcement. It is stated that the bodies and trailers will continue to be built at Plymouth, but the plant operation will be directed from Peoria. No change in personnel is expected except for additions to all departments.

Highway Profits for Everyone!

This train of WARCO Wheeled Scoops is turning around to go back after three more heaping loads of dirt on a road job. The Contractor does a good job, and the Public gets a good road through the efficiency of WARCO Wheeled Scoops, in excavating, loading, hauling and spreading earth.

For real earth moving economy, WARCO Wheeled Scoops can't be beat.

W. A. RIDDELL COMPANY

BUCYRUS - - - OHIO

Power Graders—Wheeled Scoops—Rear-Type Crawlers for Tractors

ROAD & CLAY MACHINERY STEEL CASTINGS

FAST!

$195.00 F. O. B. GALION, OHIO WITH 1½ YD. CAPACITY BODY

IT ACTUALLY PAYS FOR ITSELF IN THE TIME IT SAVES

WRITE TO-DAY for bulletins showing the complete line of Coal, Contractor and Garbage Bodies with the NEW PERFECTION HYDRAULIC HOIST the HEAVY DUTY job FOR THE Ford OR CHEVROLET

Prices you cannot afford to overlook

PERFECTION STEEL BODY CO.

DEPARTMENT R. S. GALION, OHIO, U. S. A.

PERFECTION HYDRAULIC DUMPING UNIT

R & H Company Elects New Officers

At the annual meeting of the directors of the Roessler & Hasslacher Chemical Company, Inc., held recently in New York City, the following officers were elected: Chairman of Board, W. F. Harrington; President, Hector R. Carveth; Vice-president, Mortimer J. Brown; Vice-pres. and Secy., Colby Dill; Vice-presidents, Milton Kutz and E. A. Rykenboer; Treas. Albert Frankel; Asst. Treasurer, August Heuser; Assistant Secretaries, M. D. Fischer, E. A. Howard and J. Carlisle Swaim.

Two of the newly elected vice-presidents, Dr. E. A. Rykenboer and Dr. M. J. Brown, are from Niagara Falls and will continue to make their headquarters there, while the newly-elected secretary, Colby Dill, will be located in New York City.

This company operates three plants, the largest of which is in Niagara Falls. The other two are in Perth Amboy, N. J., and El Monte, California. The company's central office is at 10 East 40th Street, New York, with branch offices in thirteen cities of the United States and a sales office in Mexico City.

Early in 1930 Roessler & Hasslacher Chemical Company, Inc., was merged with E. I. du Pont de Nemours and Company, Inc.

Announcement

Henry Earle Riggs, for many years head of the department of Civil Engineering, University of Michigan, has established an office at 527 East Liberty Street, Ann Arbor, Michigan and will devote his entire attention to engineering practice.

Mr. Riggs will give particular attention to problems growing out of railroad and public utility regulation. His services will be available as counsel in the preparation of engineering testimony for presentation to courts and commissions; for the valuation of properties and the organization of records of fixed property; studies of depreciation, of trends of construction prices and operating costs, etc., and the presentation, in the form of expert testimony of the conclusions drawn from such studies, and the development of methods for accurately bringing to date former valuations, and eliminating the expense of repeated appraisals.

It is stated that Mr. Riggs does not desire to engage in any work of design or supervision of construction, and will not seek any work of a competitive nature, but prefers to limit his practice to consulting along the lines stated.

Announcement

The Euclid Crane & Hoist Co. of Cleveland, Ohio, announces that its name has been changed to Euclid-Armington Corporation as of July 1, 1931. On and after this date, the Road Machinery division of the Euclid Crane & Hoist Co. will manufacture and sell the well known line of Euclid earth moving equipment comprising Euclid "Track-Wheel" wagons; hydraulic bulldozers; automatic wheel and rotary scrapers, and tamping rollers, under the name of the Euclid Road Machinery Co. of Euclid-Armington Corporation.

The officers of the Euclid Road Machinery Co. are: A. P. Armington, president and general manager; W. G. Fleming, vice-president and general sales manager; H. J. Zimmerman, vice-president and works manager; S. F. Armington, secretary and chief engineer; G. A. Armington, treasurer; A. Horton Bassett, assistant treasurer.

The officers and personnel of Euclid-Armington Corporation remain the same as before the change.

The business of the Road Machinery division of the Euclid Crane & Hoist Co. during the first six months of 1931 has been of such volume as to necessitate removal to new quarters adjacent to its present location. With the improved and increased manufacturing facilities available in these new quarters, the Euclid Road Machinery Co. will further improve the former high standard of Euclid quality and prompt service.

Communications formerly addressed to the Road Machinery division of the Euclid Crane & Hoist Co. should, in the future, be addressed to the Euclid Road Machinery Co., Chardon Road, Cleveland, Ohio.

Cutler-Hammer Elect New Officers

At the annual meeting of Cutler-Hammer, Inc., held recently in Milwaukee, Wisconsin, Frank R. Bacon, former chairman of the board of directors, was elected president to fill the vacancy caused by the death of Beverly L. Worder. The office of chairman of the board was abolished.

Frank R. Bacon, President, Cutler-Hammer, Inc., Milwaukee, Wis.

Other officers and directors were elected as follows: Vice-presidents, F. L. Pierce, J. C. Wilson; treasurer, H. F. Vogt; secretary, W. C. Stevens; directors, F. R. Bacon, F. L. Pierce, J. C. Wilson, H. F. Vogt, W. C. Stevens, T. Johnson Ward (of Cassatt & Company, Philadelphia), Carl A. Johnson (president of the Gisholt Machine Co., Madison), L. A. Lecher (of Bottum, Hudnall, Lecher, McNamara & Michel, Milwaukee), G. S. Crane (general sales manager of Cutler-Hammer), and E. A. Bacon (vice-president of the First Wisconsin National Bank).

J. C. Wilson, Vice-President, Cutler-Hammer, Inc., Milwaukee, Wis.

By Their Wisdom Asses Are Known

At the beginning of things, when the world was young, the donkey was esteemed by all the tribes of men as wisest of animals. The good Sheik El-Kandee owned a great herd of these sagacious beasts, which was the pride and joy of his life.

Other Sheiks from miles around came to listen and marvel at the wisdom of the herd. At such a time came even the Prophet himself—most learned and wise of all the sons of the East. With much glowing pride, El-Kandee led him out to the herd and said:

"Behold, O Prophet, the wise and talented asses! Converse with them, test them and see if they are not verily wiser than forty trees full of owls."

Then the Prophet addressed the asses. "Let us test your wisdom," said he. "Answer me this question: What would an ass require for a three days' journey!"

And they counseled among themselves and then made reply: "For a three days' journey, O Prophet, any ass should require six bundles of hay and three bags of dates."

"Very good," quoth the Prophet; "that soundeth like a fair and proper price." Whereupon El-Kandee broke into loud chuckles and said: "Did I not tell you they are passing wise?"

The Prophet answered: "Wait," and he again addressed the asses, "I have for one of you," he said, "a three days' journey, but I will not give six bundles of hay and three bags of dates for making it. Let him who will go for less stand forth."

And behold they all stood forth and all began to talk at once. One would go for six bundles of hay and two bags of dates. Then another for three bundles of hay and one bag of dates, until finally one especially long-eared ass agreed to go for one bundle of hay.

Then spoke the Prophet, "Fool," quoth he, "you cannot even live for three days on one bundle of hay, much less profit from the journey."

"True," said the long-eared one, "but I wanted to get the order."

And from that far-off day to this, asses have been known as fools, and price cutters known as asses.

From an Unknown Source.

The DeVilbiss Company, Toledo, Ohio, has recently announced a change in location of two of their sales and service branches.

The St. Louis Sales and Service Branch has moved from 1903 to 1937 Washington Avenue.

The New York Sales and Service Branch has moved from 25 West 43rd Street to 25 West 45th Street.

A representative line of spray-painting and spray-finishing equipment, accessories and hose, is on display at these sales and service branches. A full line of parts is also carried and service is maintained for the convenience of DeVilbiss customers.

The "STOLLE JUNIOR" SPREADS ROAD MATERIAL FROM ANY DUMP TRUCK

Save all the costly labor of hand spreading, also the attendant waste of material, by spreading directly from the trucks with which you haul the material to the job. In addition, the "STOLLE JUNIOR" will do better work for you and more of it without a murmur.

Write for complete bulletins.

STOLLE ROAD EQUIPMENT COMPANY
3010 LaSalle St., St. Louis, Mo.

HERCULES ROLLERS

TODAY RIGHT NOW HERCULES IS THE BEST

Road roller leadership based on yesterday's performance and design means nothing today -- It is today's performance, the ability to meet present day needs with speed, power and flexibility to out-work and out-last ordinary rollers that has won HERCULES the foremost position in the road roller field.

If you will make comparison, you will buy a HERCULES

SOLD ONLY THROUGH DISTRIBUTORS

THE HERCULES COMPANY—MARION, OHIO

ANTHONY PIPELESS HYDRAULIC

HEAVY DUTY

$198.00

COMPLETE
F. O. B. Streator, Ill.

1—Pipeless—no plumbing to leak or give way.
2—Gallon Reserve—carried in reservoir prevents air locks and oil foaming; no stopping for lack of oil.
3—Heavy Duty—will handle all chassis will stand.
4—Double Strength Hoist—starts to raise load ahead of center of body.
5—50° Dumping Angle.
6—High tailgate clearance.
7—Positive control at all times.
8—Low Loading Height.

ANTHONY COMPANY INC.
STREATOR, ILLINOIS

A fourteen wheeled

MODERN MARVEL

The Rogers Line includes trailers for every purpose—small units for handling tractors, rollers, etc., medium sized standard trailers for profitably hauling ninety per cent of the loads encountered and multi-wheeled carry-alls such as here illustrated.

All are built to one uniform standard of design and proved practical by years of gruelling service.

ROGERS GOOSE NECK TRAILER

ROGERS BROS. CORP.
116 Orchard St., Albion, Pa.

Write for Catalog NO. 28

Service Exchange
for Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Diesel engine account, road building material and equipment line, and industrial equipment and materials seeking representation in south wanted by Florida distributor. Large warehouse facilities.

Well established company, warehouse facilities, desires new lines for Pittsburgh or adjacent territory. Thirty years' experience contacting contractors.

High-grade salesman desires quality lines on commission basis in all or part of Ohio, Michigan and Indiana. Will devote entire time to one line if conditions warrant.

Equipment distributor in Pacific northwest desires line of road-building equipment, structural building equipment, dump bodies and truck hoists.

Wanted, agency for any type of building specialties or contractors' machinery except mixers. Twenty years' experience.

Sales engineer, experienced in earth-moving machinery, desires connection on salary or salary and commission basis. Wide acquaintance with machinery dealers, oil and gas industry, pipeline contractors and material men. References.

Wanted, line of picks, sledges and crow bars, spades, shovels and similar implements by New York broker, with warehouse facilities, contacting New York and New Jersey jobbers.

Distributor situated in Portland, Ore., desires line of stationary diesel engines, from 75 to 150 hp., to serve western trade for driving rock crushers and industrial plants.

Distributor situated in Virginia wishes to make connection to represent manufacturer of manganese crushing plates and jaw rock crushers.

Manufacturer's representative situated in New York City, now handling pumping machinery, would like to take on two or three additional lines serving the same field as his present account.

Distributor covering Wisconsin and Illinois territory wishes to add to present lines. Thoroughly familiar with bituminous materials and equipment for handling.

Wanted, line of street markers or other traffic equipment on exclusive basis by distributor covering New Jersey and New York territory.

Export manager for American manufacturer of road graders is in a position to handle an additional line of non-competing construction machinery, for manufacturer seeking foreign representation.

Manufacturer's representative with 25 years' sales experience, conversant with all types of pumps and their field, desires agency for either New York or export territory or both.

Manufacturer's representative, covering Massachusetts, Rhode Island and southern New Hampshire, would like to secure line of speed reducers and gears.

Representative in northwest desires to handle on commission basis line of road building and maintenance machinery, revolving scarpers, tractors, rotary snow plows and V-type push plows.

Distributor with large warehouse, show room and service facilities, desires two or three additional lines. Maintains large sales organization, covering New York, Vermont, Maine, Massachusetts and Connecticut.

▼

Representatives Wanted

Manufacturer of a new tractor dump wagon has a number of desirable territories open. Full cooperation extended to distributors.

Manufacturer of power shovels and well drills has desirable open territory for agencies in several Nebraska, Iowa, Minnesota and Wisconsin counties. Write for information.

Wanted agency for building specialties and contractors implements by Ohio manufacturers' agents. Warehouse facilities and acquaintance with contractors and dealers.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer of contractors and builders levels and transits is seeking district sales manager. Exclusive contract given. Excellent territory still available. Backed by national advertising.

Long established and well-known manufacturer of industrial locomotives wishes to make contacts with qualified distributors. Locomotive line includes steam, gasoline, gas-electric and oil-electric. Supported by national trade journal advertising.

Manufacturer of asphalt ingredient adaptable for use in the road or industrial field, is seeking representatives for desirable territory in various parts of the country.

Manufacturer of patented highway and zone marking machine desires sales representatives who are acquainted with highway officials in their own state.

Manufacturer of steel dump bodies and oil heaters seeking distribution points in west central and southern states, including Missouri, Kansas, Iowa, Nebraska, Colorado, Kentucky, Tennessee, Mississippi, Arkansas, Louisiana and western half of Illinois.

Eastern manufacturer bringing out new mechanical chip spreader is seeking representation for this product.

Manufacturer of portable electric tools, used by building contractors, offers exclusive territory to agents handling this line on straight commission basis. References required.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full cooperation will be extended to distributors.

Southwest and middle-west distributors wanted by manufacturer of metal lath, corner beads, channels and reinforcing mesh.

Attractive territory open in states south and west of Chicago by manufacturer of cut-to-length, easily-erected standardized steel highway bridges, for spans up to and including 40 ft. Product sells to highway commissioners and superintendents.

Manufacturer of complete line street repair equipment, tar kettles, heaters, patching plants, torches, etc., has open territory in southeastern states and desires active distribution. Territory largely open from Virginia to gulf states, inclusive, also state of Oklahoma.

Manufacturer of construction equipment, mixers, saw rigs, plaster and mortar mixers and pumps has an open territory in the state of Maine and is looking for an aggressive distributor.

Manufacturer of patented reflecting signs and devices desires representatives for New York City, Long Island, Westchester County and adjacent territory. Some one selling other products to municipalities preferred.

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

Manufacturer of patented luminous highway danger signs and signals is interested in securing aggressive representation in various parts of this country and Canada.

Open territory in New York and New England states for aggressive distributor wishing to take on line of hoisting machinery and air compressors.